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Jul 78

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This Draft EIS concerns the issuance of an NPDES permit to Occidential Chemical Company for the construction of a new chemical plant in Hamilton County, Florida. The construction of the new Swift Creek Chemical Complex is part of a two-phased plan to increase the superphosphoric acid capacity of the north Florida phosphate fertilizer manufacturing complex. The facility will require approximately 50 acres for the plant and 275 acres each for a gypsum stack and cooling pond. Potential sources of pollution are air emissions (suflur dioxide, particulates, and fluorides), process water and nonprocess water. Impacts of emissions on air quality and surface and ground water were examined.

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PB 286 044

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30308

EPA 904/9-78-012-D
JULY 1978

DRAFT

EPA

Environmental Impact Statement

Occidental Chemical Company
Swift Creek Chemical Complex
Hamilton County, Florida

Resource Document
Volume IV

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SECTION 3.0

ENVIRONMENTAL EFFECT OF PROPOSED NEW SOURCE

3.1 AMBIENT AIR QUALITY WITH THE PROPOSED SOURCES

The imapct of sulfur dioxide (SO_2) and particulate matter emissions from existing and proposed sources was determined by air quality modeling as described in Section 2.2.1.1. The period of time represented by this evaluation is 1979, the year in which the proposed project is to be completed. The impact of fluoride emissions from the proposed facility was determined by qualitatively projecting fluoride effects measured and observed under existing conditions. Occidental is the only source of these pollutants impacting on the study area and Occidental has no current plans for further expansion. For this reason, the air quality projected for 1979 has been assumed to be representative of air quality that will exist over the next 10 years.

The impact of the proposed sources was evaluated by EPA in January, 1978. Prevention of Significant Deterioration and New Source Review approval was granted in February, 1978 (EPA, 1978). This signifies that EPA has reviewed the proposed action and found that it will not cause air quality standards to be violated, that it will not cause air quality to be significantly degraded, and that SO_2 and particulate matter emissions from the proposed sources will satisfy New Source Performance Standards or Best Available Control Technology.

The county-wide emission burdens of CO, NO_x and hydrocarbons were projected through 1990.

3.1.1 AIR EMISSIONS FROM PROPOSED SOURCES

The air pollutants emitted from the proposed sources in significant quantities are SO_2, particulate matter and fluorides. The SO_2 and particulate matter will be emitted from point sources in quantities readily estimated. Fluorides will be emitted from the phosphoric acid plant and superphosphoric acid plants in readily estimated quantities and from cooling water and gypsum ponds at rates estimated between 0.1 and 10 pounds per acres per day (EPA, undated).

3.1.1.1 Sulfur Dioxide Emissions From Proposed Sources

Sulfur dioxide from the proposed sources will be emitted from the two sulfuric acid plants, the auxiliary boiler associated with the sulfuric acid plants and from the heaters associated with the four superphosphoric acid plants. These emission rates will be limited by New Source Performance Standards and Best Available Control Technology (BACT).

The annual average and short-term emission rates of SO_2 from these sources are listed in Table 3.1-1.

The design stack height for the sulfuric acid plant stacks is 200 feet. "Good Engineering Practice" stack height allowed for the stacks in accordance with the Clean Air Act Amendment of 1977 is 125 feet. The stack height of 125 feet (38 meters) was used for all air quality modeling.

3.1.1.2 Particulate Matter Emissions From Proposed Sources

Particulate matter from the proposed sources will result from acid mist emissions from the sulfuric acid plants and particulate matter emissions from the auxiliary boiler associated with the sulfuric acid plants, from the phosphoric acid plant and from the superphosphoric acid plants. These emissions are summarized in Table 3.1-2.

3.1.1.3 Fluoride Emission Inventory for Proposed Sources

Fluorides from the proposed Swift Creek sources will result from fluoride emissions from the phosphoric acid plant, the superphosphoric acid plants and the acid clarifiers. The fluoride emissions from the acid plants will be limited by New Source Performance Standards for these sources. The emissions from the acid clarifiers are limited by BACT. These emissions will total 0.08 pounds of fluoride per ton of P_2O_5 plant capacity or 112 pounds of fluoride per day.

In addition to these well defined emissions, fluoride emissions will also result from cooling water and gypsum ponds. Fluoride emissions from ponds was discussed in Section 2.2.2.3.1. In this section it was concluded that fluoride emissions from ponds could be in the range of 0.1 to 10.0 pounds per acre per day. The pond area associated with the proposed sources is 230 acres. Fluoride emissions from these ponds will be proportional to the surface area of the ponds.

3.1.2 CALCULATED SULFUR DIOXIDE LEVELS WITH PROPOSED SOURCES

Ambient SO_2 levels were calculated for the annual average, 24-hour and 3-hour periods using procedures described in Section 2.2.1.1. The calculated SO_2 concentrations are presented in tabular and graphical form.

Isopleths of the annual average SO_2 concentrations for the 1979 period are presented in Figure 3.1-1. The data in this figure are summarized in Table 3.1-3. The calculated SO_2 levels for the second-high 24-hour and 3-hour periods are presented in Figures 3.1-2 and 3.1-3, respectively. The data from these figures are also summarized in Table 3.1-3.

In reviewing these data and comparing these data with data representing the 1977-78 period, it will be noted that there are only slight increases in the calculated SO_2 levels caused by the proposed sources. The reason for this is that most of the proposed sources are to be located 7.5 kilometers west of existing chemical complex at the proposed Swift Creek Chemical Complex.

The maximum calculated annual SO_2 levels for 1979 is 21 micrograms per cubic meter. This compares with a maximum annual sulfur dioxide level of 20 micrograms per cubic meter for the 1977-78 period. The Florida Department of Environmental Regulation (FDER) annual SO_2 standard is 60 micrograms per cubic meter and the federal standard is 80 micrograms per cubic meter.

The maximum calculated 24-hour SO_2 concentration in the area for the 1979 period is 250 micrograms per cubic meter compared with a level of 254 micrograms per cubic meter in 1977-78. This occurs northwest of the existing chemical complex on Occidental property. The maximum 24-hour SO_2 concentration predicted at the Swift Creek site is 147 micrograms per cubic meter, an increase of 49 micrograms per cubic meter over the 1977-78 level. These levels are below the primary and secondary air quality standards of 265 micrograms per cubic meter and 250 micrograms per cubic meter, respectively.

The highest 3-hour SO_2 level calcualted for the Swift Creek site is 281 micrograms per cubic meter. This compares with a level of 35 micrograms per cubic meter in 1977-78. At the existing chemical complex the highest 3-hour SO_2 level was calcualted to be 1224 micrograms per cubic meter. These calculated levels compare with 1300 micrograms per cubic meter, the national secondary air quality standard.

3.1.3 CALCULATED TOTAL SUSPENDED PARTICULATE MATTER LEVELS WITH PROPOSED SOURCES

Ambient TSP levels were calculated for the 1979 period using air quality modeling techniques described in Section 2.2.1.1. For the 1979 period, the annual average and 24-hour TSP levels were calculated, the latter being claculated for several receptors.

The annual average and 24-hour average TSP levels for 1979 are presented in Figures 3.1-4 and 3.1-5, respectively. These data are summarized in Table 3.1-4.

These data show that in 1979 the highest average annual TSP level predicted for the area is only 3 micrograms per cubic meter above the background level of 31 micrograms per cubic meter. This is the same level that was predicted for the site during the 1977-78 period. The highest annual TSP level predicted for the Swift Creek site in 1979 is 32 micrograms per cubic meter.

It will be noted that, as in 1979, the highest calculated 24-hour average TSP level occurs just west of the existing chemical complex. This level is calculated to be 116 micrograms per cubic meter including 61 micrograms per cubic meter of background particulate matter level. The same level was calculated for the 1977-78 period.

At the Swift Creek site, the calculated 24-hour TSP level for the 1979 period is 78 micrograms per cubic meter. This includes 61 micrograms per cubic meter of background particulate matter level and is only 1 microgram per cubic meter greater than the level calculated for the 1977-78 period.

The air quality standards that these calculated levels compare with are the National primary annual and 24-hour standards of 75 $\mu g/m^3$ and 250 $\mu g/m^3$, respectively; and the national secondary annual and 24-hour standards of 60 $\mu g/m^3$ and 150 $\mu g/m^3$, respectively. The calculated TSP levels around the Occidental site are well below these standards.

3.1.4 THE ENVIRONMENT WITH PROPOSED FLUORIDE EMISSIONS

Fluoride emissions from phosphate fertilizer plants have been determined to be welfare related; i.e. there is no impact on human health (EPA, 1976).

Fluorides from the proposed facility will result from emissions from the phosphoric acid plant, the four superphosphoric acid plants, the associated acid clarification facility, and the cooling water and gypsum ponds. The emissions from the proposed sources will be 112 pounds of fluoride per day. Emissions from existing sources will be approximately 379 pounds of fluoride per day. Pond emissions are proportional to area and range from 0.1 to 10.0 lb/acre-day (Section 2.2.2.3.1). The existing pond area is approximately 412 acres and the proposed pond area is approximately 230 acres.

Existing levels of fluoride in the ambient air over a four-month period range from 0.7 to 1.0 micrograms per cubic meter with 24-hour concentrations ranging to 5.1 micrograms per cubic meter. Fluoride levels in grass during the most critical seven months of the year ranged from 25 to 46 ppm total fluoride with the exception of samples collected near cooling water ponds. There is no evidence of fluoride damage to vegetation and no significant effects have been noted in cattle (see Section 2.2.2.3.2).

Because of the magnitude of fluoride emissions from the proposed sources and the fact that new sources will be located 7.5 kilometers west of the existing sources, it is expected that fluoride levels in fluoride effects from the proposed sources will be less than the observed effects resulting from existing activities.

3.1.5 PROJECTED EMISSION BURDENS OF CO, NO_x, AND HYDROCARBONS

The emission burdens of CO, NO_x, and hydrocarbons were calculated for 1979. Since these pollutants result principally from mobile sources, sources which will increase in time, the emission burdens were also projected to 1990. These data are summarized in Table 3.1-5.

The Occidental contribution to the CO burden is 1.0 percent in 1978. It increases to 1.9 percent in 1979 and decreases to 1.5 percent in 1990.

The proposed sources will contribute NO_x as a result of fuel combustion. These will increase the 1978 Occidental contribution to the NO_x burden (42 percent) to 56 percent in 1979. This contribution will then decrease to 51 percent in 1990.

Hydrocarbon emissions result primarily from automotive sources. In 1978, Occidental contributed only 1.7 percent of the hydrocarbons emitted in Hamilton County. This will increase to 3.0 percent in 1979 and decrease to 2.5 percent in 1990.

The county-wide emission of these pollutants is currently at a low level. The increase resulting from the proposed expansion will be small and the incremental impact will be significant.

3.1.6 NOISE LEVEL IMPACT/CONSTRUCTION

The construction site for the proposed chemical complex just north of the existing ore processing plant in the Swift Creek mine area is shown in Figure 1.4-1. The installations will include two sulfuric acid plants, two superphosphoric acid plants, one phosphoric acid plant, and a 125,000 lb/hr auxiliary boiler. Planned location of the plants are illustrated in Figure 3.1-6. Construction is expected to begin in mid-1978 and to be completed in late-1979.

A construction contractor, Davy Powergas, Inc., of Lakeland, Florida, who has constructed similar complexes for Occidental Chemical Company, has provided a list of major construction equipment. The number, description and times to be used in months (mo) is listed below:

EQUIPMENT LIST

1	4000W Manitawoc (150T)	12 mo
1	3900 Manitawoc (100T)	12 mo
2	90 ton Truck Cranes	12 mo
1	70 ton Truck Crane	10 mo
1	50 ton Truck Crane	10 mo
2	35 ton Hydro Cranes	12-14 mo
3	15 ton Cherry Pickers	12-14 mo
1	45 ton Listing Beam	2 mo
2	6-33 Pettibone Highlifts	14 mo
1	#12 Motor Grader	3 mo
1	D7 Dozer w/Hdy Blade	3 mo
1	22B Dragline w/Clamshell	1 mo
2	660 Gradall	1-6 mo
1	60" Vibratory Roller	3 mo
1	3-yd Front End Loader	3 mo
1	580 Case Backhoe	6 mo

1	6,000 gal. Water Truck	12 mo
2	40' Floats w/Tractors	5 mo
1	Lowboy w/Tractor	3 mo
4	125 CFM Air Compressors	12 mo
4	3" Mud Hogso	12 mo
4	Concrete Vibrators (Elec.)	6 mo
1	2 ton Air Tugger	4 mo
4	1" Dr. Air Impacts	12 mo
2	5KVA Portable Generators	12 mo
1	36" Traveling Machine	4 mo
1	90# Jack Hammer	12 mo
2	Concrete Buckets	6 mo
3	Compactors	8 mo
3	535 Pipe Machine	12 mo
8	300 amp Gas Welders	12 mo
30	250 AC/DC Electric Welders	14 mo
1	4" Concrete Pump	1 mo
3	2 ton Flat Beds	12 mo
3	14 yd. Dump Trucks	12 mo

Construction will begin at the south end of the complex and progress northward. Operations during construction are expected to proceed during four 10-hour work days per week (all daytime) and equipment will normally be in use sixty percent (24 hours per week) of the time while on-site.

With the exception of 195 foot high stacks for the sulfuric acid plants, all major construction will take place at elevations below 50 feet. A large dike (NE-SW boundary) will effectively attenuate noise propagation from construction to the east and southeast. The existing mine facilities will also act as a noise barrier to attenuate noise propagation southwards and to a lesser extent to the southwest.

Associated emission of noise during construction is expected from highway vehicles (trucks and autos) entering and leaving the site along access roads. However, the noise impact off-site is expected to be negligible from transportation activities associated with construction. Furthermore, noise emission limits for highway vehicles are regulated under the "Florida Motor Vehicle Noise Prevention and Control Act of 1974". The applicable portion of this Act is Section 316.293, Chapter 74-110, Florida Statutes on Motor Vehicle Noise. Subsection 2 delineates operating noise limits.

The model used to determine noise levels during construction assumes point sources located inside the boundary of the construction site. The maximum sustained output from any single piece of equipment is assumed to be around 30 mw acoustic power (105 dBA at point source and 85 dBA at 100 feet from a single point source). Propagation of sound is assumed to follow the spherical spreading relation with a 1.5 dB per thousand feet excess attenuation.

Site preparation of the proposed gypsum stack and cooling pond is not expected to be a major contribution to noise emissions during construction. The earth moving equipment involved in the above activities will operate at different locations over a large area east of the construction site for the complex. Furthermore, the equipment will operate below grade or near earthern mounds with consequent high attenuation. Therefore the noise from the use of construction equipment away from the chemical complex site is very roughly approximated in estimating noise level contours.

Ldn contours out to Ldn = 55 were estimated for construction noise and are shown in Figure 3.1-7. The only potentially noise sensitive area (residential) is located about nine thousand feet north of the proposed site on Highway 137. This area is well beyond the Ldn = 55 contour. In fact, the predicted construction noise level impact for residents is zero.

The high noise levels of construction equipment will require that equipment operators and nearby personnel avoid potentially hazardous (hearing impairment) noise exposures. The construction contractor will be responsible for providing engineering and administrative controls, or personal hearing protection, to assure compliance with noise exposure standards under 29 CFR 1910 (Occupational Safety and Health Act of 1970).

No significant, direct effect of construction noise levels on wildlife is anticipated.

The pertinent results of the construction noise impact study are as follows:

1. Construction activities will be restricted to daytime hours.

2. Construction noise impact off-site at the nearest residence is negligible.
3. Traffic noise impact associated with construction activities is predicted to be negligible.

Noise Level Impact/Operation

Noise level data and noise propagation data were determined from the Suwannee River mine and chemical complex (see Noise Level Surveys) and provide the basis for estimating noise levels for the Swift Creek mine and chemical complex. The major noise sources are fluid handling equipment. At distances from the plants (in the complex) comparable to or greater than the plant size dimensions, the plants may be treated as effective point sources from the center of the structure.

Directionality of noise propagation is of concern for the large blowers for the sulfuric acid plants and the auxiliary boiler. The proposed layout for the complex, Figure 3.1-6, has the two sulfuric acid plants and the boiler located in the southeast portion of the complex site. Also the highest noise level area of the sulfuric acid plant will be facing southwest-toward U.S. Highway 41. Unobstructed propagation of noise emitted by the sulfuric acid plants and boiler will be within a small angle toward the southwest. Obstructions (acting as partial noise barriers) in other directions include: dikes (earthern berms) for the proposed gypsum stack and cooling pond to the west and northwest;

the other components of the chemical complex to the north; dikes of the existing settling area to the east; the existing beneficiation plant to the south.

The phosphoric acid and superphosphoric acid plants in the northwest section of the proposed layout also have obstructions in noise propagation paths except toward the northwest. The major obstructions in close proximity to the plants are structures for product storage.

Activities during operation associated with rail movements along a spur track into the complex for sulfur delivery and product shipping is not expected to be a major noise source. Based on experience at the Suwannee River Complex, the noise level increase due to train movement will generally be 3 dBA or less (greater than 100 feet distance) during the periods of train movement. On a time integrated basis (L_{eq}), rail activity noise impact should be neglible compared to the essentially continuous emission from the plant operations.

Mining operations to provide ore for processing is expected to proceed northward from the complex site and, to a lesser extent, southwestward across U.S. Highway 41 during the next decade. Phosphate mining results in high noise levels only locally near the diesel powered earth moving machinery. Drainage ditches around the mining area have mounds of earth which act as noise barriers. The overburden is also stacked (closer) to the mining machinery. Finally, the operations (drag lines) of digging the ore matrix occurs below grade. Although mining leads to low intrusion levels of noise on the immediate surroundings, it does require that an effective Hearing Conservation Program be maintained for equipment operators.

Timber and pulpwood stands (pines) north of the proposed complex site and southwest across U.S. Highway 41 will be harvested as mining operations proceed. Cutting and removal of trees will be carried out by another corporation (Owen-Illinois) under a lease agreement with Occidental Chemical Company. The use of chain saws, logging equipment and trucks will create short periods of significant noise emission at various locations over the region near the site during the decade following completion of the complex. It is estimated, however, that on a time and area average, noise impact associated with clearing timber will be negligible compared to continuous operation of the complex.

Clearing of timber does reduce excess attenuation of noise by removing significant ground cover. Nevertheless, the cleared site will generally have dikes around the necessary drainage ditches which may offer even greater excess attenuation than the trees. Data from the Suwannee River mine area suggests that excess attenuation is compensated by field equipment (earth moving machinery to maintain canals, dikes and roads) and that noise attenuation from stationary (process plant) sources is closely predicted by distance spreading alone. During nighttime hours when operation of field equipment is curtailed, excess attenuation is assumed to yield a difference between L_d and L_n of around 10 dBA for distances greater than a mile from the complex.

The computation model for prediction of Ldn contours involves a point source with variable directional gain. The directional gain in the northeast direction is taken as zero (baseline) and, primarily, indicates emission from the phosphoric and superphosphoric acid plants. The directional gain to the southwest is taken as 10 dBA and accounts for higher emission from the sulfuric acid plants and boiler. A negative direction gain, 10 dBA, is assumed in the northwest direction. Estimated Ldn contours are shown in Figure 3.1-8.

The only noise sensitive area (residential) near the proposed complex is about nine thousand feet from the northern boundary of the complex. No intrusive noise levels from operation of the proposed complex is expected at the nearest residences off-site. For all personnel on-site, Occidental Chemical Company will continue its Hearing Conservation Programs to assure compliance with standards under 29 CFR 1910 (Occupation Safety and Health Act of 1970) and/or under 30 CFR 70 and 71 (Federal Mine Safety Act).

The impact of increased noise levels on wildlife cannot be predicted with any degree of certainty in connection with operation of the proposed chemical complex. No evidence is available to suggest a significant impact directly related to expected noise levels.

The noise impact study for operation of the proposed Swift Creek Chemical Complex determined that:

1. The plant will operate on an essentially continuous basis.

2. Noise impact off-site at the nearest residence due to plant operation is negligible.
3. The increase in roadway and railway traffic associated with proposed plant operation will result in negligible noise level impact.

Table 3.1-1. Sulfur Dioxide Emission Data for Proposed Sources for Occidental Chemical Company, White Springs, Florida

	Emission Rate		Stack Data				Source Location	
Source	Annual (Tons/Day)	Maximum (gr/sec)	Height (m)	Temp. (°K)	Velocity (m/sec)	Dia. (m)	X Cord. (km)	Y Cord. (km)
SPA Heaters (SRCC)	1.33	15.5	30.5	468.0	11.8	2.29	28.90	68.90
SPA Heaters (SCCC)	1.33	15.5	15.3	468.0	11.8	2.29	21.10	69.85
Sulfuric Acid E	3.60	42.0	61.0	356.0	30.6	1.83	20.95	69.82
Sulfuric Acid F	3.60	42.0	61.0	356.0	30.6	1.83	20.90	69.70
Aux Boiler (Sulfuric Acid)	1.23	12.9	15.3	468.0	9.5	2.32	20.90	69.75

Table 3.1-2 Particulate Matter Emission Data for Proposed Sources for Occidental Chemical Company, White Springs, Florida

Source	Emission Rate		Stack Data				Source Location	
	Annual (Tons/Day)	Maximum (gr/sec)	Height (m)	Temp. (°K)	Velocity (m/sec)	Dia. (m)	X Cord. (km)	Y Cord. (km)
SPA Heaters (SRCC)	0.005	0.06	30.5	468.0	11.8	2.29	28.90	68.90
SPA Heaters (SCCC)	0.005	0.06	15.3	468.0	11.8	2.29	21.10	69.85
Sulfuric Acid E	0.135	1.58	61.0	356.0	30.6	1.83	20.95	69.82
Sulfuric Acid F	0.135	1.58	61.0	356.0	30.6	1.83	20.90	69.70
Aux Boiler (Sulfuric Acid)	0.013	0.53	15.3	468.0	9.5	2.32	20.90	69.75

Table 3.1-3. Summary of Maximum Calculated Ambient SO_2 Levels from Proposed and Existing Sources for Occidental Chemical Company, Hamilton County, Florida

Averaging Time	Sulfur Dioxide Air Quality Standard		Site: Suwannee River Chemical Complex		Site: Swift Creek Chemical Complex	
	State	Federal	1977-78	1979	1977-78	1979
Annual	60(1)	80(2)	20	21	7	8
24-Hour	260(1)	365(2)	254	259	98	147
3-Hour	1300(1)	1300(1)	1212	1224	35	281

(1) Equivalent to the National Secondary Air Quality Standard

(2) National Primary Air Quality Standard

Note: All values in micrograms per cubic meter.

Table 3.1-4. Summary of Maximum Calculated Ambient TSP Levels from Proposed and Existing Sources for Occidental Chemical Company, Hamilton County, Florida

Averaging Time	Particulate Matter Air Quality Standard		Site			
			Suwannee River Chemical Complex		Swift Creek Chemical Complex	
	State	Federal	1977-78	1979	1977-78	1979
Annual[a]	60(1)	75(2)	34	34	32	32
24-Hour[b]	150(1)	260(2)	116	116	77	78

[a] Includes 31 micrograms per cubic meter background.

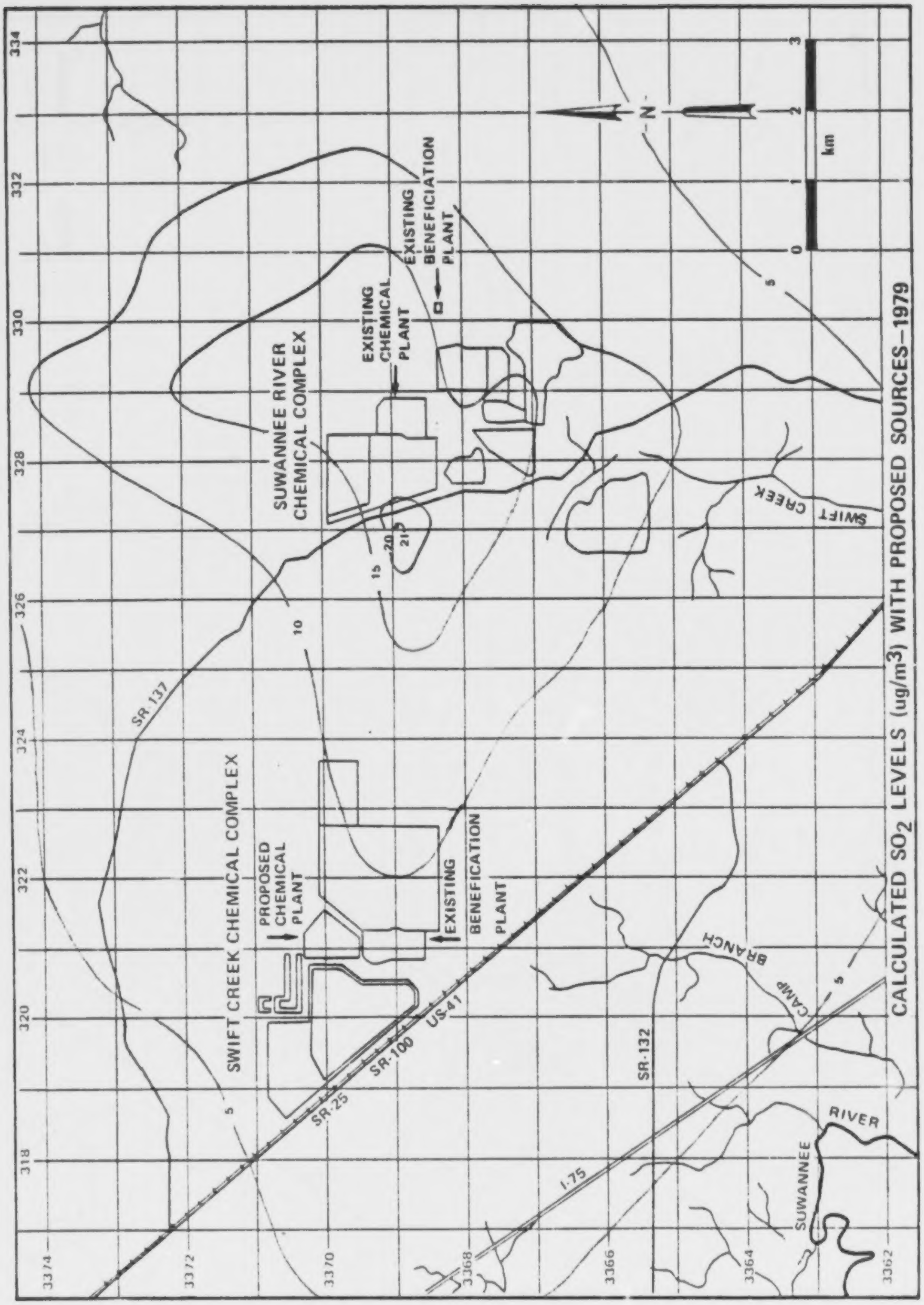
[b] Includes micrograms per cubic meter background.

(1) Equivalent to the National Secondary Air Quality Standards

(2) National Primary Air Quality Standard.

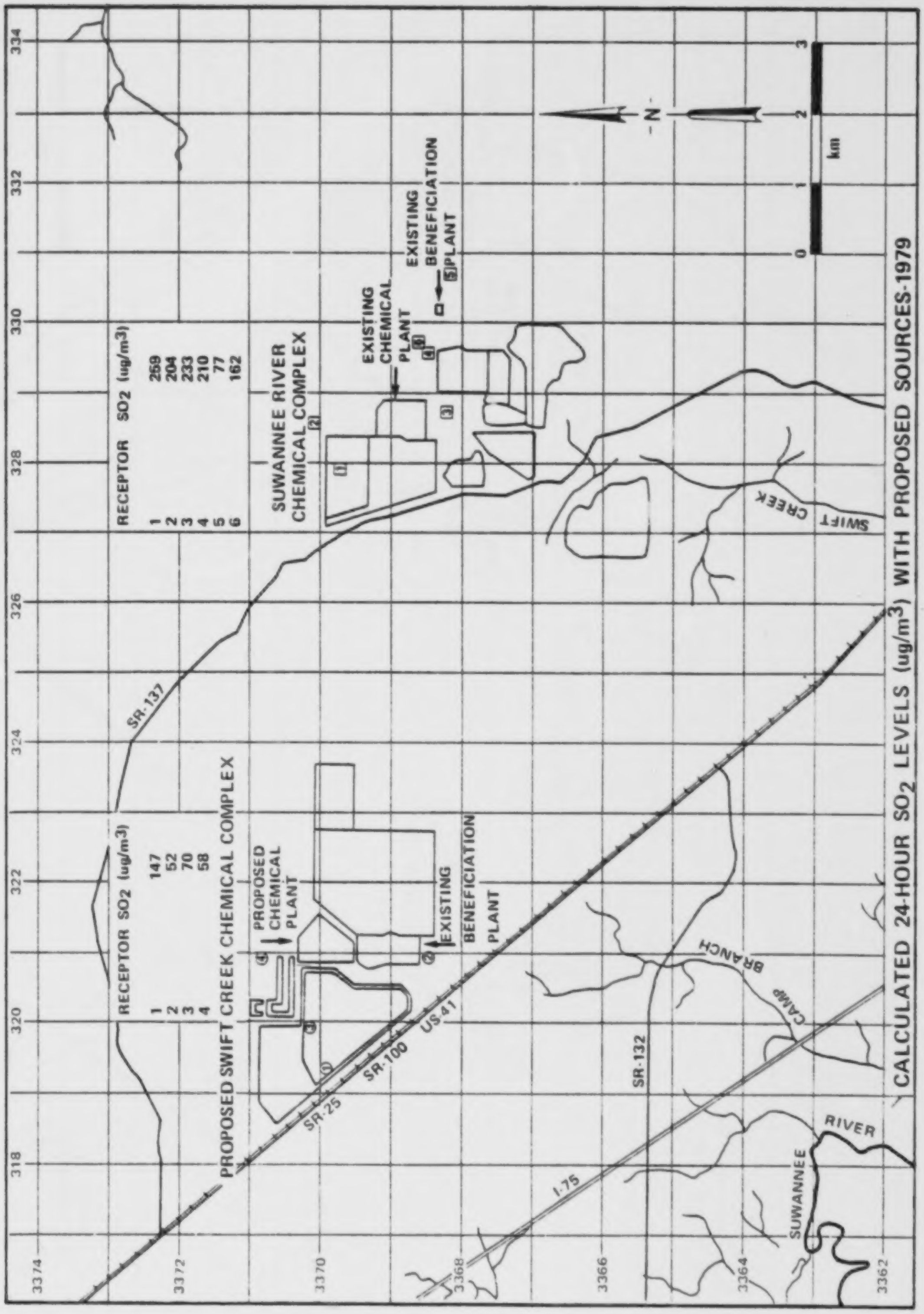
Table 3.1-5. Projected Emission Burdens of CO, NO_x, and Hydrocarbons for Hamilton County, Florida

		Pollutant (tons/year)		
Period	Source	CO	NO_x	Hydrocarbons
1977-78	Highways	5001	873	635
	Dwellings	1	6	0
	Point Sources	53	640	11
	Total	5055	1519	646
1979	Highways	5151	899	654
	Dwellings	1	6	0
	Point Sources	96	1154	20
	Total	5248	2059	674
1990	Highways	6201	1082	787
	Dwellings	1	9	1
	Point Sources	96	1154	20
	Total	6298	2245	808


SWIFT CREEK CHEMICAL COMPLEX
PROPOSED CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
SUWANNEE RIVER CHEMICAL COMPLEX
EXISTING CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
SR-137
SR-25
SR-100
US-41
SR-132
I-75
CAMP BRANCH
SWIFT CREEK
SUWANNEE RIVER
N
km
0
1
2
3
5
10
15
20
21
318
320
322
324
326
328
330
332
334
3374
3372
3370
3368
3366
3364
3362

CALCULATED SO_2 LEVELS (ug/m^3) WITH PROPOSED SOURCES—1979

FIGURE 3.1-1


PROPOSED SWIFT CREEK CHEMICAL COMPLEX
RECEPTOR SO2 (ug/m3)
1 147
2 52
3 70
4 58
PROPOSED CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
SUWANNEE RIVER CHEMICAL COMPLEX
RECEPTOR SO2 (ug/m3)
1 269
2 204
3 233
4 210
5 77
6 162
EXISTING CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
N
km
0
1
2
3
SR-137
SR-25
SR-100
US-41
SR-132
I-75
CAMP BRANCH
SWIFT CREEK
SUWANNEE RIVER
318
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326
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330
332
334
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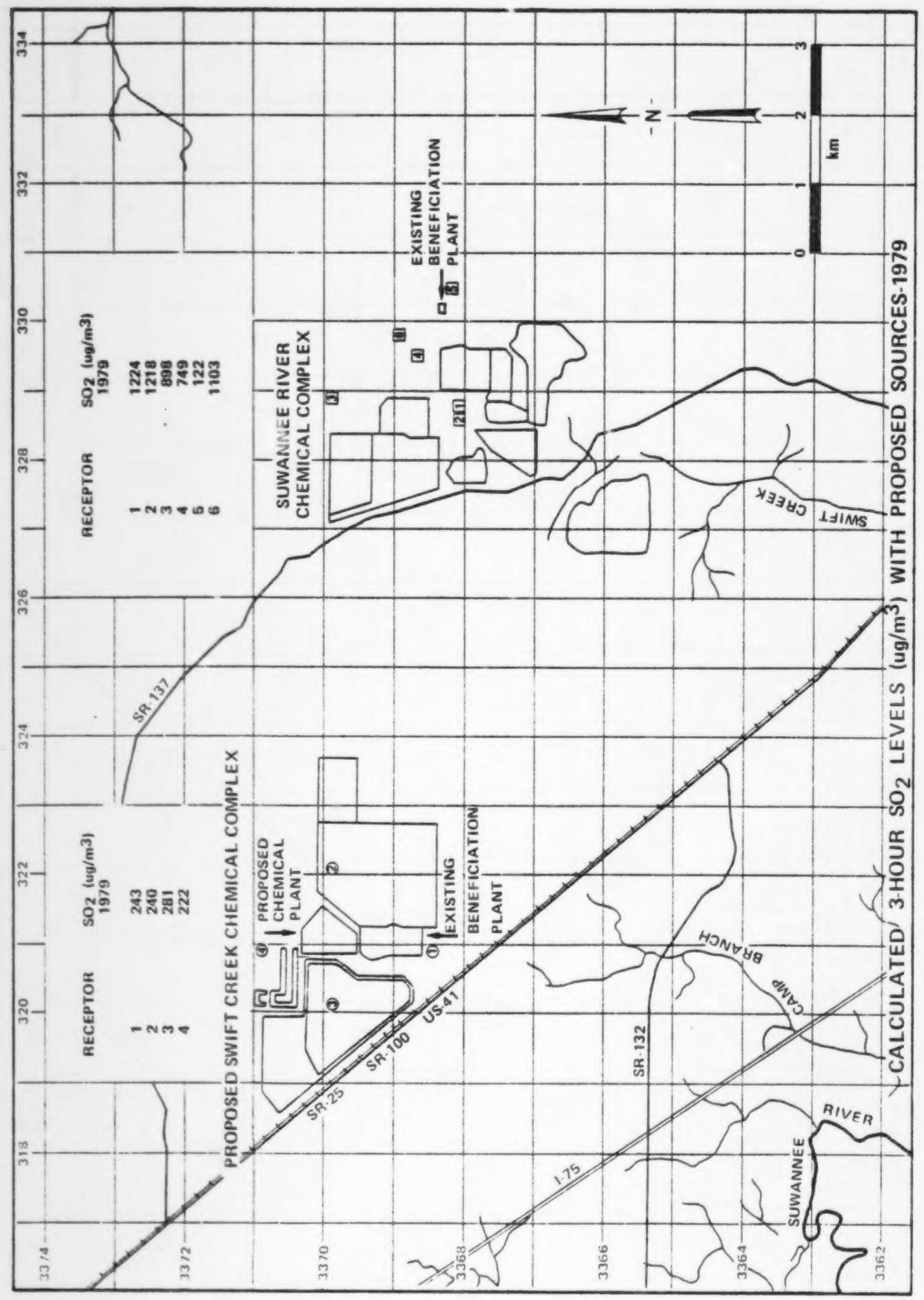
CALCULATED 24-HOUR SO_2 LEVELS (ug/m^3) WITH PROPOSED SOURCES-1979

FIGURE 3.1-2


PROPOSED SWIFT CREEK CHEMICAL COMPLEX
SUWANNEE RIVER CHEMICAL COMPLEX
PROPOSED CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
EXISTING BENEFICIATION PLANT
SR-137
SR-25
SR-100
US-41
SR-132
I-75
CAMP BRANCH
SWIFT CREEK
SUWANNEE RIVER
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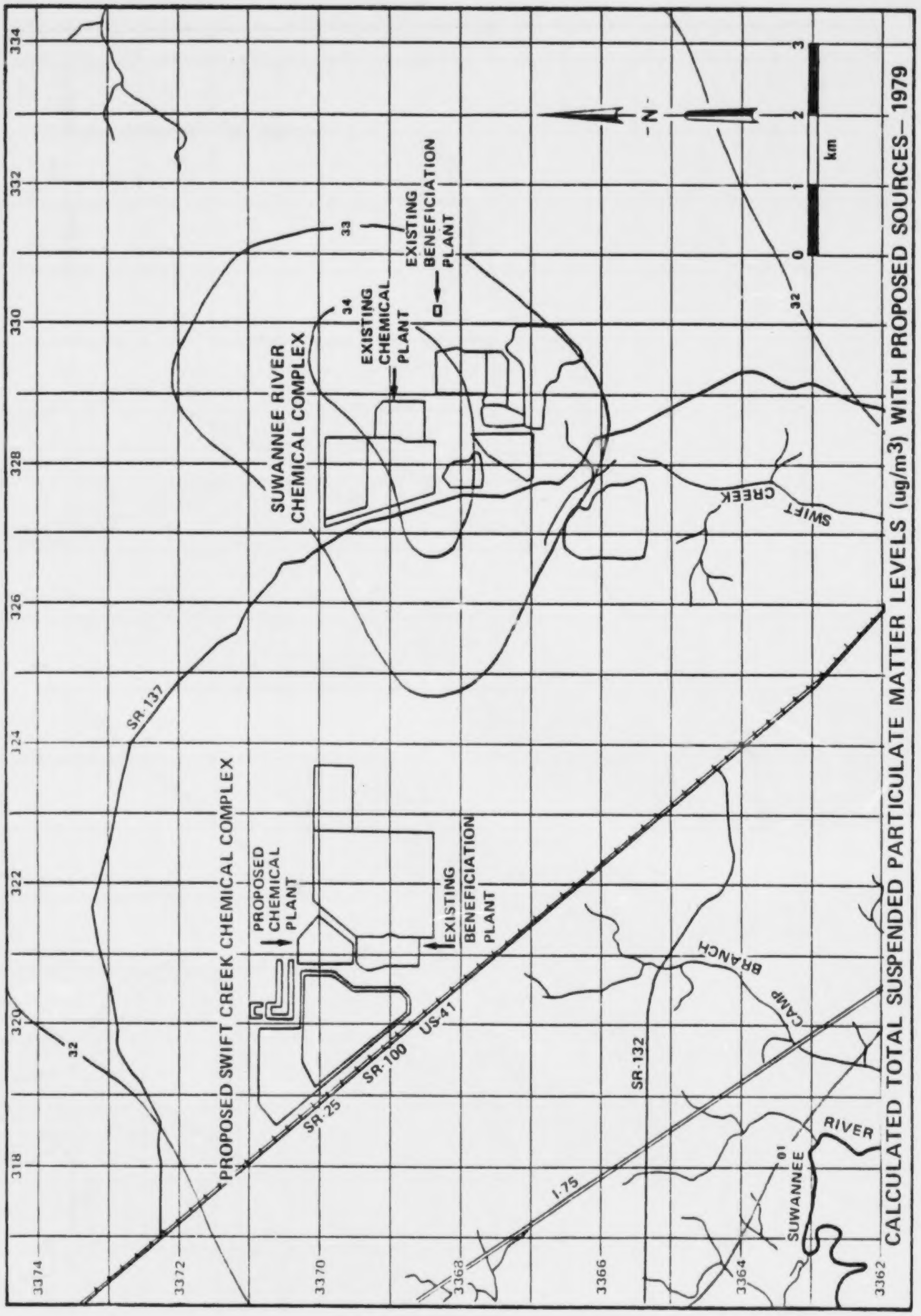
318
320
322
324
326
328
330
332
334
3374
3372
3370
3368
3366
3364
3362

RECEPTOR	SO2 (ug/m3) 1979
1	243
2	240
3	281
4	222

RECEPTOR	SO2 (ug/m3) 1979
1	1224
2	1218
3	898
4	749
5	122
6	1103

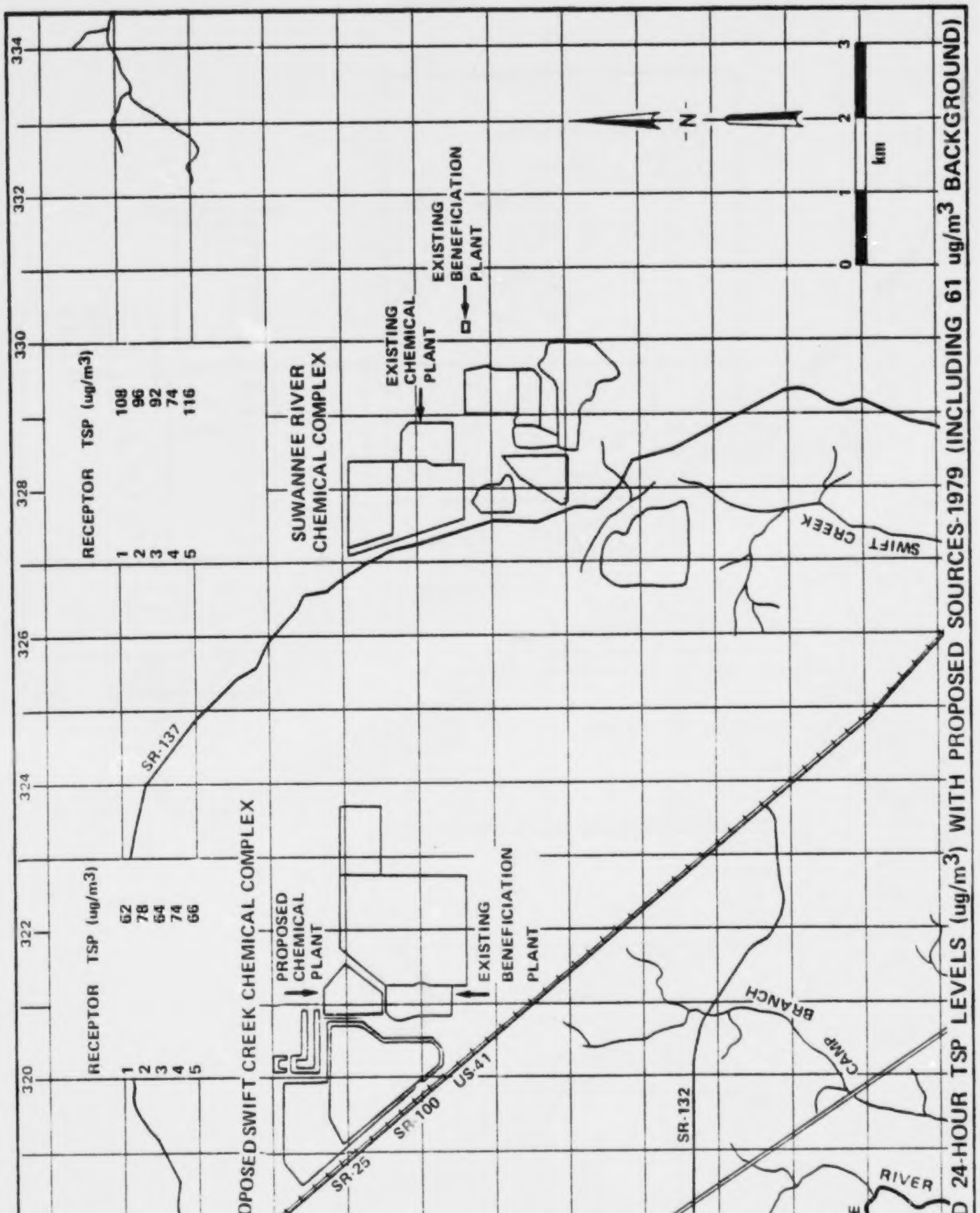
CALCULATED 3-HOUR SO_2 LEVELS (ug/m^3) WITH PROPOSED SOURCES-1979

FIGURE 3.1-3


PROPOSED SWIFT CREEK CHEMICAL COMPLEX
PROPOSED CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
SUWANNEE RIVER CHEMICAL COMPLEX
EXISTING CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
N
km
0
1
2
3
32
33
34
32
SR-137
SR-25
SR-100
US-41
I-75
SR-132
SWIFT CREEK
CAMP BRANCH
SUWANNEE
RIVER
318
320
322
324
326
328
330
332
334
3374
3372
3370
3368
3366
3364
3362

CALCULATED TOTAL SUSPENDED PARTICULATE MATTER LEVELS (ug/m3) WITH PROPOSED SOURCES– 1979

FIGURE 3.1-4



CALCULATED 24-HOUR TSP LEVELS (ug/m^3) WITH PROPOSED SOURCES-1979 (INCLUDING 61 ug/m^3 BACKGROUND)

PROPOSED SWIFT CREEK CHEMICAL COMPLEX

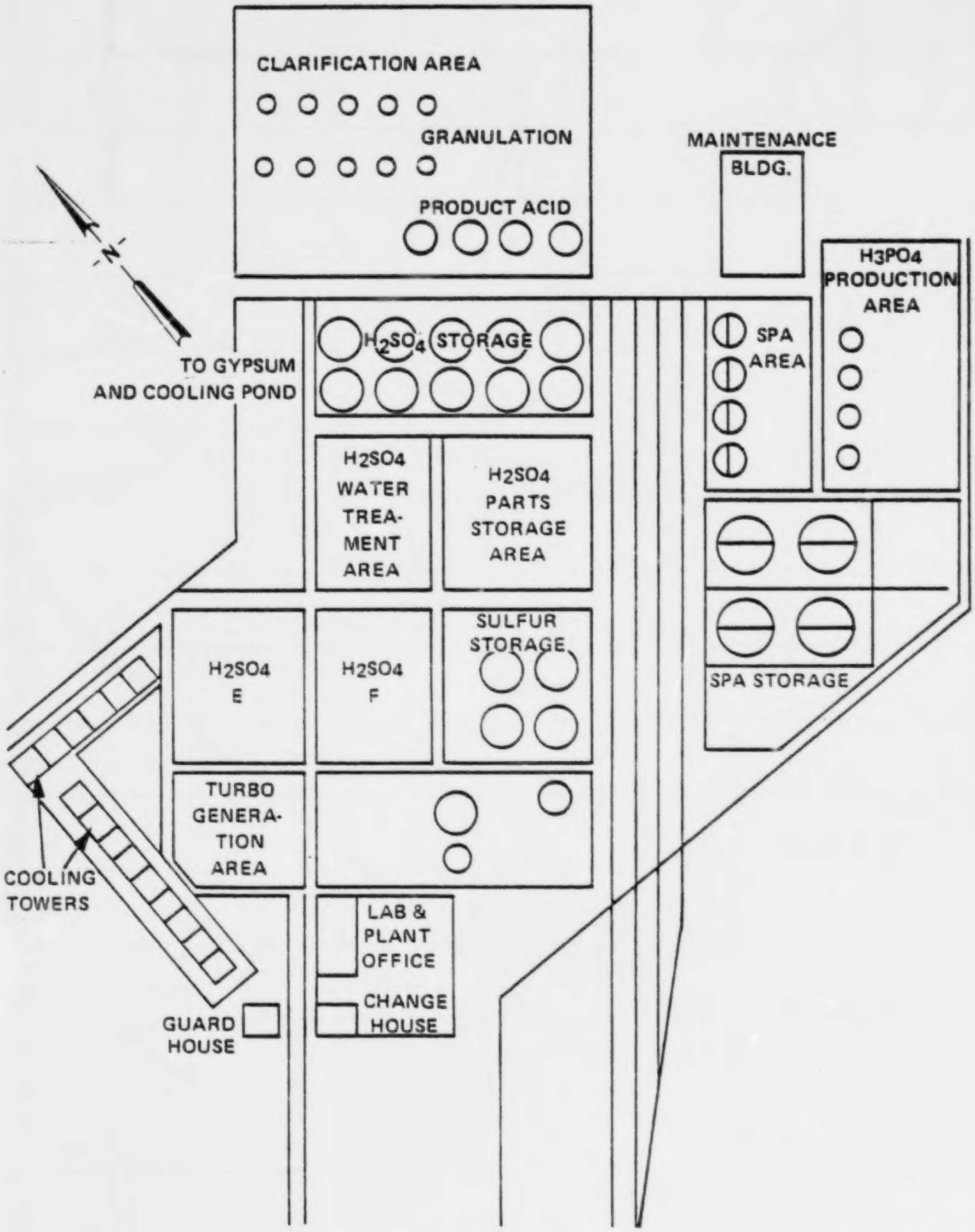
RECEPTOR	TSP (ug/m3)
1	62
2	78
3	64
4	74
5	66

SUWANNEE RIVER CHEMICAL COMPLEX

RECEPTOR	TSP (ug/m3)
1	108
2	96
3	92
4	74
5	116

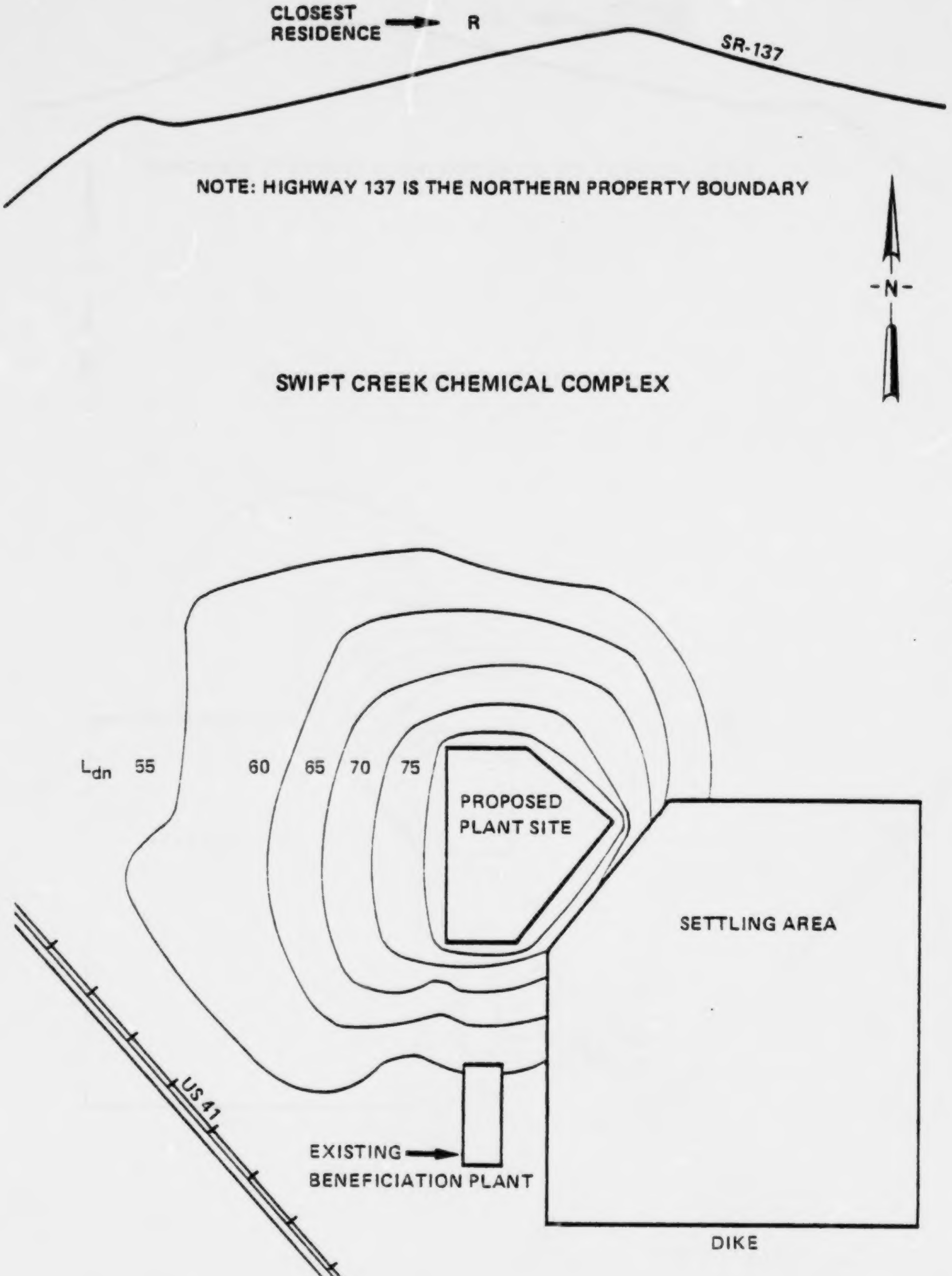
PROPOSED CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
EXISTING CHEMICAL PLANT
EXISTING BENEFICIATION PLANT
SR-137
SR-25
SR-100
US-41
SR-132
I-75
CAMP BRANCH
SWIFT CREEK
SUWANNEE RIVER
N
0
1
2
3
km
318
320
322
324
326
328
330
332
334
3374
3372
3370
3368
3366
3364
3362

FIGURE 3.1-5


CLARIFICATION AREA
GRANULATION
PRODUCT ACID
MAINTENANCE BLDG.
H3PO4 PRODUCTION AREA
N
H_2SO_4 STORAGE
TO GYPSUM AND COOLING POND
SPA AREA
H2SO4 WATER TREA-MENT AREA
H2SO4 PARTS STORAGE AREA
SULFUR STORAGE
H2SO4 E
H2SO4 F
SPA STORAGE
TURBO GENERA-TION AREA
COOLING TOWERS
LAB & PLANT OFFICE
CHANGE HOUSE
GUARD HOUSE

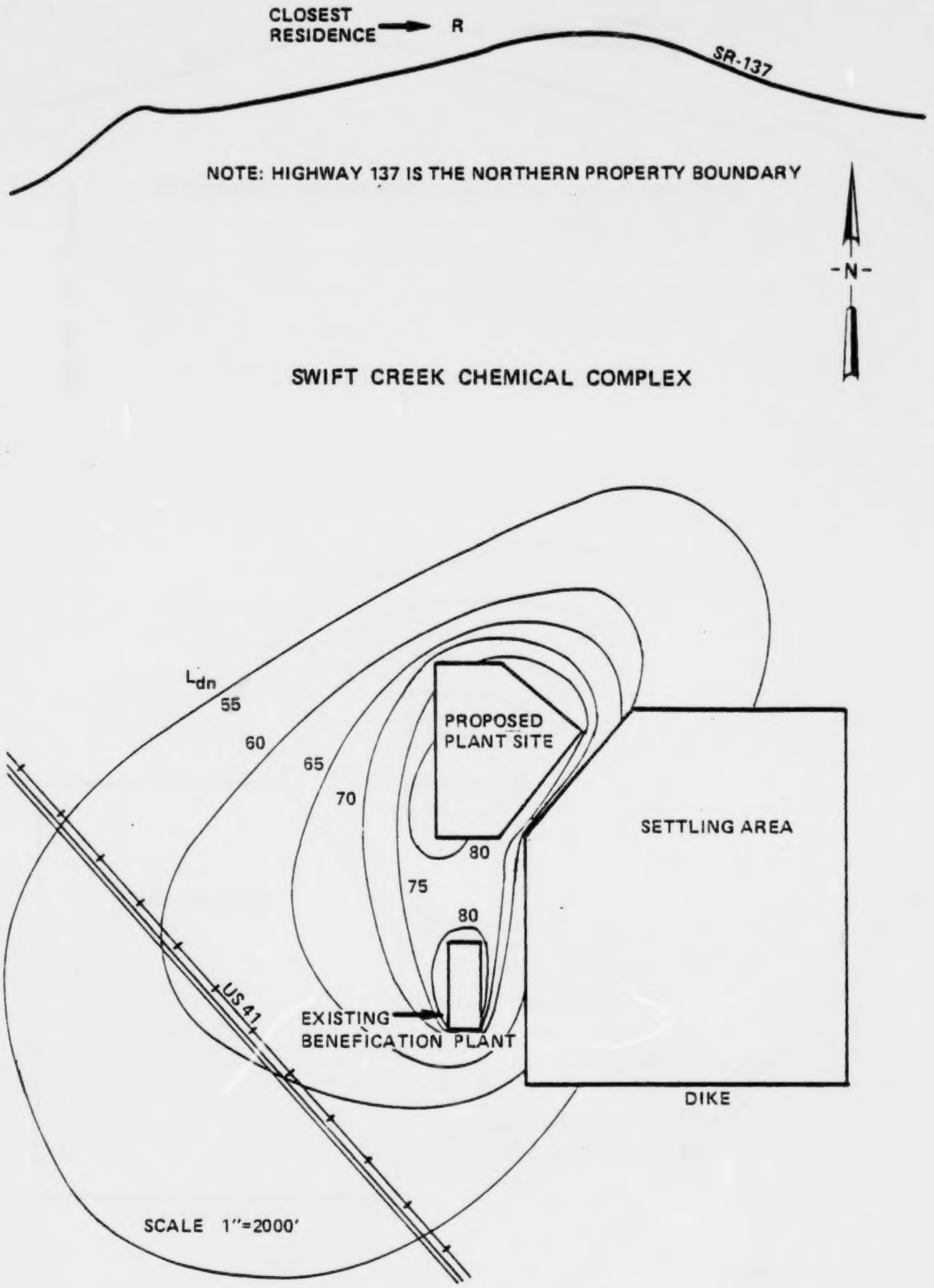
PLOT PLAN – SWIFT CREEK CHEMICAL COMPLEX– OCCIDENTAL CHEMICAL CO.

FIGURE 3.1-6


CLOSEST RESIDENCE
R
SR-137
NOTE: HIGHWAY 137 IS THE NORTHERN PROPERTY BOUNDARY
-N-
SWIFT CREEK CHEMICAL COMPLEX
L_{dn} 55
60
65
70
75
PROPOSED PLANT SITE
SETTLING AREA
US 41
EXISTING BENEFICIATION PLANT
DIKE
SCALE 1"=2000'

L_{dn} CONTOURS-CONSTRUCTION

FIGURE 3.1-7


CLOSEST RESIDENCE
R
SR-137
NOTE: HIGHWAY 137 IS THE NORTHERN PROPERTY BOUNDARY
N
SWIFT CREEK CHEMICAL COMPLEX
L dn
55
60
65
70
75
80
80
PROPOSED PLANT SITE
SETTLING AREA
US 41
EXISTING BENEFICATION PLANT
DIKE
SCALE 1"=2000'

L_{dn} CONTOURS— CONTINUOUS PLANT OPERATION

FIGURE 3.1-8

LIST OF REFERENCES
(Section 3.1)

EPA (Undated), "Evaluation of Emissions and Control Techniques for Reducing Fluoride Emissions from Gypsum Ponds in the Phosphoric Acid Industry"; U.S. Environmental Protection Agency, U.S. Chemical Processes Section, IERL, Contract 68-02-1330, Task No. 3, Research Triangle Park, North Carolina.

EPA (1976), "Final Guideline Document: Control of Fluoride Emissions From Existing Phosphate Fertilizer Plants", Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park, North Carolina, November 1976.

EPA (1978), "Letter from John C. White, Regional Administrator, to Mr. W.W. Atwood, Occidental Chemical Company, Granting PSD Approval - Dated February 27, 1978".

3.2 LAND AND WATER RESOURCES

3.2.1 TOPOGRAPHY AND DRAINAGE BASINS

The proposed Swift Creek Chemical Complex is located wholly in the Swift Creek drainage basin. Therefore, alterations to the original topography within the proposed boundaries of the chemical complex will not result in an alteration of the drainage basin divides.

The proposed gypsum stack-cooling pond complex will, however, occlude certain areas from natural drainage to Swift Creek. This will amount to approximately 550 to 600 acres or about two percent of the 42 square mile drainage basin of Swift Creek at its point of confluence with the Suwannee River.

Significant alterations to the original relatively flat topography will occur as the gypsum stack reaches maturity. The gypsum stack is expected to reach a height from 60 feet to 100 feet above natural grade. This would impact an area of about 350 acres. In addition, surface water bodies would increase as a result of the cooling pond which would cover approximately 200 to 240 acres.

As described in Section 5.2.3.3, reclamation of the gypsum stack prior to abandonment could consist of flattening its slopes and incorporating a clayey soil cover that would be grassed.

3.2.2 GEOLOGY

3.2.2.1 Stratigraphy

Mining operations at the site of the proposed cooling pond-gypsum stack chemical complex will alter the natural stratigraphy of the surficial sediments to a maximum depth of about 55 feet, by displacement of the overburden and removal of the ore matrix. The impact of the chemical plant is to dispose of gypsum in mined-out pits created within the proposed area of the stack, an area of up to 350 acres. Neither activity will adversely affect the integrity of the main stratigraphic units; i.e., the primary Hawthorn confining bed and the underlying Floridan Aquifer limestone.

3.2.2.2 Sinkholes

The site is located in a region with a very low probability for sinkhole occurrence under existing hydro-geologic conditions.

Increased pumping from the Floridan Aquifer and the added hydraulic head and static load from the gypsum stack tend to slightly increase the probability for sinkhole occurrence. The likelihood of activating a sinkhole remains, however, very remote as evidenced by the performance of existing facilities in the site vicinity; e.g., the existing Dorr Oliver Gypsum Stack at the Suwannee River Chemical Complex, clay waste settling areas and dams, rock stock piles and higher rates of pumping than proposed for the Swift Creek Chemical Plant from a number of existing wells. Some of these facilities have been in existence for more than 10 years in this area without triggering any sinkhole in the region.

3.2.3 SOILS

3.2.3.1 Erosion Control

During construction of the plant site and the gypsum stack-cooling pond complex, several area, not yet disturbed by mining activities, will be cleared of natural vegetation. These areas will include the building, pavement and storage areas on the plant site, the base of earthen retaining dikes, borrow areas used to obtain structural fill for the plant site and for the earthen embankments, and unmined areas within the gypsum stack-cooling pond complex.

The building, pavement, and storage areas will be grubbed only as necessary prior to construction. Erosion will be minor (less than 2 tons per acre) and all sediment will be collected in ditches surrounding the plant site.

The base of the embankment and the borrow areas will be grubbed only as required for the section under construction. The borrow areas are not a source of erosion because they will be excavated immediately after grubbing. Some erosion of the earthen embankments is expected during construction. Runoff from the embankments will be collected and clarified before it is permitted to enter surface water courses, with further clarification occurring at Eagle Lake prior to discharge into Swift Creek.

The largest areas that will be cleared of natural vegetation will be those areas that will be mined prior to being incorporated into the chemical complex. Such areas are cleared of marketable resources, such as trees and other cover crops, and grubbed of all vegetation from one to two months prior to mining. The grubbed areas are typically 330 feet wide and 1500 to 3000 feet long. Most of the property that will be grubbed is fairly level and is underlain by poorly drained fine sands characterized by a low potential for erosion (Section 2.5.4). It should be noted that clearing, grubbing, and mining will be undertaken whether or not these areas are used for the proposed chemical plant complex.

Because of the different slopes involved and the variable intensity and duration of rainfall, it is not possible to accurately calculate the total quantity of erosion which will occur due to the removal of natural vegetation. However, the average annual soil loss from a completely barren area 1500 feet long could be as high as 60 tons per acre per year if the grubbed surface has a 2 percent slope. Since the areas are generally mined within a month or two after clearing and generally have slopes flatter than 2 percent, the expected erosion from a given barren area would be less than 2 to 4 tons per acre or less than 23 to 46 tons for a mining area 330 feet wide and 1500 feet long.

Runoff from exposed areas will be collected in perimeter ditches and in adjacent mine pits and will be clarified before it is released from the property. Soil eroded from overburden piles and from the unprotected slopes of the embankments prior to the establishment of a good grass cover will also be collected in ditches and mining pits to meet Florida water quality discharge standards.

3.2.3.2 Dust Potential

The surficial soils on the subject property generally contain less than 15 percent by weight of particles smaller than 0.06 mm (i.e., dust-sized particles) and these particles are intimately mixed with particles of fine sand (0.1 to 0.5 mm). If the surficial soil has vegetative cover and/or is moist, due to a high water-table for instance, the soil particles will not move even under heavy winds. However, if the vegetation is removed and the surficial soil dries out, for example after stripping borrow pits or mining areas, the sand-sized particles can be moved if the wind has a velocity of 20 miles per hour measured at 25 feet above ground surface.

Although embedded dust particles are not directly erodible by the wind, they can be set into motion by the bombarding effect of moving sand particles and by moving vehicles or animals. In their natural state, the surficial soils have no real dust potential (Section 2.5, Table 2.5-3) and, because the wind velocity is seldom strong enough to put the sand grains in motion, the surficial soils in grubbed areas have a low dust potential except when subjected to heavy construction traffic.

Even then, the dust potential is only moderate because of the small percentage of dust-sized particles and the limited acreage uncovered at any one time. Nevertheless, when dusting becomes noticeable, the heavily trafficked areas are generally wetted down with water trucks to minimize maintenance expense of the construction equipment.

During the active life of the plant, the roads within the chemical complex will be paved to prevent dusting. Other areas disturbed during construction will be grassed. Thus, the dust potential will be practically eliminated and will revert to natural conditions.

3.2.3.3 Land Use and Gypsum Stack Retirement

Existing soils at the site of the proposed chemical complex are nearly level and poorly drained. The proposed gypsum stack-cooling pond complex is totally located within the Leon-Mascotte-Rutlege Association (Section 2.5) which, overall, has a low potential for crop production, but a high potential for improved pasture with proper water management. Its capability for pine woodlands ranges from low to moderate. On-site, these soils have traditionally been used for pine timber or pulpwood production. Since the area affected by the chemical complex is limited to approximately 600 acres, removal of this land from potential agricultural or silvicultural usage should not have a major impact, particularly because the existing soils require special conservation practices and careful management due to poor drainage and high water table levels.

Impacts of the gypsum stack after retirement are not readily identifiable since there are no known stacks that have been completely retired and reclaimed. Potential impacts would include some dusting from climatologic drying and wetting cycles, and leaching as rain water percolates through the stack. Dusting and erosion are not a problem during the active life of the stack since gypsum possesses self-cementing characteristics and the active stack is not subjected to severe cycles of wetting and drying. Mitigative measures to reduce and/or eliminate the potential impacts of a retired gypsum stack are discussed in Section 5.2.3.3.

3.2.4 SURFACE WATER QUANTITY

3.2.4.1 Average Flow of Swift Creek

The proposed gypsum stack-cooling pond complex will occlude approxi-550 to 600 acres from natural drainage. This results in a reduction of the Swift Creek flows by an average of about 0.5 cfs over a long-term period. The decrease in flow amounts to less than one percent of the current flow in Swift Creek at its point of confluence with the Suwannee River.

This reduction in flow will, however, be overridden by the discharge of non-process water, much of it derived from the Floridan Aquifer, that did not normally contribute to the flow in Swift Creek. Non-process water discharged to Swift Creek from full development of the Swift Creek Chemical Complex will average approximately 2.2 cfs over extended periods (and will equal about 2.6 cfs over time periods when the Chemical Plant is in full operation; i.e., running at 100 percent efficiency). The overall effect of occlusion of the gypsum stack and cooling pond areas from natural drainage (0.5 cfs decrease) and discharge of non-process water (2.2 cfs increase) will yield an average net increase in flow of about 1.7 cfs during the active life of the plant.

Therefore, average flows of Swift Creek with the proposed development will be increased by 1.7 cfs above the present flows at all monitoring stations below the Eagle Lake discharge point. A hydrograph showing the daily discharge as measured at the USGS Facil Station for the water years 1976 and 1977 is presented in Figure 3.2-1. Superimposed on this hydrograph is the net effect of the addition of 1.7 cfs to the daily flows. The minimal impact of this increase in flow is apparent from a comparison of the two hydrographs. The additional flow will increase the current flow of Swift Creek at its point of confluence with the Suwannee River by about 3 percent resulting in no measurable increase in scour.

3.2.4.2 Low Flows of Swift Creek

Base flow to Swift Creek during periods of low flow will not be reduced by the proposed facility because the impact on groundwater levels in the surficial aquifer is minimal and very localized. The main ponded area to be added as a result of the new facility is the cooling pond. During periods of increased evaporation corresponding to a drought, the water level in the below-ground cooling pond will still be maintained within the operating level at only few feet below ground surface through the addition of process (and, if needed, non-process) waters originating from the Floridan Aquifer. Consequently, there will be no measurable reduction of base flow as a result of the new facility even during drought periods.

The storage provided by various existing ponded areas in the mining development, such as Eagle Lake, and non-process water discharges from the proposed plant could be used to augment low flows. On the average, based on a mass balance of stream loading at White Springs and Suwannee Springs (upstream and downstream of the Swift Creek confluence with the Suwannee River), the existing records show that during periods of low flow, discharges from the Occidental property have been approximately 40 percent and 27 percent of the long-term average discharge for the mean annual 7-day low flow (M7,2) and the 10-year 7-day low flow (M7,10), respectively. It is probable that the proposed plant will have similar reduced discharges at low flow since Occidental is likely to curtail its discharges to conserve water required in the circulation system during drought, increasing the M(7,2) and M(7,10) low flows on the average by about 0.6 to 0.9 cfs, respectively.

However, the lowest flows of a stream will occasionally be associated with the simultaneous occurence of a drought and a shutdown of operations. In this event, there will be no impact from the proposed facility on low flows in Swift Creek.

3.2.4.3 Flood Flows of Swift Creek

The gypsum stack-cooling pond complex would somewhat attenuate peak flows in Swift Creek because storm precipitation within the system is stored, at least temporarily, prior to being treated and discharged, if needed. The gypsum-stack cooling pond system is designed for "zero" discharge; i.e., rainfall from the 25-year/24-hour storm can be stored within the system. The cooling pond will be designed to maintain 1.5 times the volume of precipitation from the 25-year/24-hour storm without infringing on the necessary freeboard. The reduction in peak flows should not, however, be appreciable and will probably be offset by non-process discharges. The impact of the proposed chemical plant is not significant with respect to the flood flows and the corresponding flood levels produced by the 2-, 5-, 25-, 50- and 100-year floods in Swift Creek.

Prolonged flooding of low flood plain areas by intermediate flows can have an effect on the ecology of these areas. Section 2.6.2.2.4 presented the effect of the existing facilities on intermediate flows of 100, 140, and 165 cfs that can continue for several days or weeks at a time. It was concluded that current discharges from the Swift Creek Mine, Suwannee River Mine and Suwannee River Chemical Complex have raised the water levels of Swift Creek by about 0.35 feet during the wet season. Under these conditions, the stream has been observed to be nearly bankfull. The additional discharge from the Swift Creek Chemical Plant should not increase the water level of the stream by more than

0.05 feet at any point during comparable periods of intermediate flows.

3.2.4.4 Suwannee River Flows

Changes in the rate of flow caused by the development of Swift Creek Chemical Complex will not be perceptible on measured flows in the Suwannee River because of the relative size of the Suwannee River. The average increase in flow in Swift Creek amounts to less than 0.1 percent of the average Suwannee River flow at its point of confluence with Swift Creek.

3.2.5 GROUNDWATER QUANTITY

3.2.5.1 Surficial Aquifer

The groundwater level in the surficial aquifer will not be significantly affected by the proposed facilities since the water level in the below-ground cooling pond surrounding the gypsum stack would be maintained within a few feet of the ground surface (see Section 3.2.7.2). Seepage from the gypsum stack and above-ground cooling pond will flow to the adjacent below-ground cooling pond because it acts as a sump in the surrounding flat topography. Any potential effect on the groundwater surrounding flat topography. Any potential effect on the groundwater levels in the surficial aquifer would be very localized and confined to the immediate vicinity of the facility. Hence, water availability within the surficial aquifer should not change as a result of the proposed chemical complex.

3.2.5.2 Hawthorn Confining Unit and Secondary Artesian Aquifer

The proposed facility will have no impact on the Hawthorn confining unit.

The secondary artesian aquifer located in permeable zones within the Hawthorn Formation is not areally extensive. Potential pumping from this aquifer would be limited to small capacity potable wells and the effect of this pumping would be very localized.

3.2.5.3 Floridan Aquifer

It is anticipated that 2611 gpm (3.76 MGD) of groundwater will be required during the operation of the proposed chemical plant. This water will be supplied from a single well of 7000 gpm design capacity located at the plant site and tapping the Floridan Aquifer to a depth of about 800 feet.

An evaluation of the reduction in the elevation of the potentiometric surface of the Floridan Aquifer that will result from the proposed withdrawals was made using a value of transmissivity of 66,000 ft^2/day and a leakance value of 3.2×10^{-6} day^{-1} (Sections 2.6.3.3 and 2.6.3.4).

The drawdown of the potentiometric surface which would result from pumping a well at 2611 gpm under steady-state conditions is shown in Figures 3.2-2 and 3.2-3. Steady-state conditions are reached when the cone of depression caused by the pumping stops expanding because the amount of induced recharge occurring within the cone equals the pumping rate. The lowering of the potentiometric surface will be greatest at the well and will decrease with distance from the well. As shown, the potentiometric surface will decrease by about 7 feet at a distance of 500 feet away from the well; it will decrease by less than 3.5 feet at 10,000 feet away from the well.

The actual decline of the potentiometric surface resulting from the proposed withdrawals would be even lower than estimated above because the natural leakage to the Floridan Aquifer at the outer edge of the zone of influence (e.g., in the Coastal Lowlands along the channel of the Suwannee River) is expected to be larger than that used in the simplified analysis, and because there will be some capture of groundwater underflow.

The decrease in the potentiometric surface of the Floridan Aquifer would increase the recharge rate (and hence decrease surface runoff). However, the amount of increased recharge (and decreased stream flow) is very small. For example, at a distance of 100 feet from the well, the 9-foot projected lowering of the potentiometric surface would increase the existing recharge rate of 1.0 in/yr to 1.11 in/yr. At distances of 1,000 and 10,000 feet, the existing recharge of 1.0 in/yr would be increased to 1.07 and 1.04 in/yr, respectively.

The maximum recharge would occur under the gypsum stack when it reaches maturity because of the additional hydraulic head difference created by ponding water on top of the stack. This applied head could reach 100 feet when the stack is mature, at which time the natural recharge rate of 1.0 in/yr would increase to a maximum of 2.3 in/yr. This increased recharge will be supplied from water currently in storage in the Hawthorn confining unit and will be limited to the area of the gypsum stack. The impact on groundwater quality is addressed in Section 3.2.7.

3.2.6 IMPACTS OF THE PROPOSED SWIFT CREEK CHEMICAL COMPLEX ON SURFACE WATER QUALITY

3.2.6.1 Estimated Amounts and Composition of the Discharge From the Proposed Swift Creek Chemical Complex (SCCC)

The SCCC will regularly discharge nonprocess water and rainfall runoff and will infrequently discharge treated process water when a seasonal imbalance in rainfall over evaporation occurs.

3.2.6.1.1 Nonprocess Water

The nonprocess water discharge will be approximately 2.2 cfs as an annual average. Stormwater runoff from the plant site will add approximately 0.2 cfs. Thus, the total discharge of nonprocess water will be approximately 2.4 cfs as an annual average. The water will pass through Eagle Lake within a detention time of about 150 days before entering Swift Creek.

The chemical composition of the nonprocess water discharge must be estimated. It is logical to assume that the discharge will be quite similar to the existing Suwannee River Chemical Complex (SRCC) discharge, with one exception.

Ammonia-nitrogen levels in the discharge will be much lower than those in the SRCC nonprocess water because ammonia-nitrogen will not be used. No diammonium phosphate (DAP) will be produced. Thus, the only sources of ammonia in the nonprocess water will be due to natural sources, such as rainfall, microbial decomposition, excretion from animals and groundwater. A value of 1 mg/l ammonia-nitrogen was estimated for the nonprocess water discharge. Because unpolluted natural waters and well water seldom have ammonia-nitrogen levels totalling above 0.5 mg/l, the 1.0 mg/l value should be a conservative value from an impact standpoint.

To determine values for other parameters in the nonprocess water discharge, the SRCC discharge was examined and estimates were made (Table 3.2-1) for the composition of the SRCC nonprocess water based on long-term monitoring for fluorides and phosphate and grab samples for the other parameters.

3.2.6.1.2 Treated Process Water

Little data are available on the chemical composition of treated process water since it is infrequently discharged and extensive analyses have not been made. Table 3.2-2 gives a typical analyses of process water before and after treatment by the two stage limestone-lime process.

3.2.6.2 Impact of Nonprocess Water Discharges

3.2.6.2.1 Method of Calculating Impacts

The impact due to the discharge of SRCC nonprocess water was calculated as follows:

$$C_N = \frac{C_1 \times Q_1 + C_2 + Q_2}{Q_1 + Q_2}$$

where:

C_N = new concentration due to SRCC

C_1 = present concentration

C_2 = estimated concentrations in SRCC nonprocess water

Q_1 = present flow

Q_2 = estimated flow of SRCC nonprocess water.

Suwannee River and Swift Creek flows were taken from Table 2.6-1. Nonprocess water discharge was estimated as 2.4 cfs based on water balances calculated in Section 1.3 and hydrological determinations (Section 2.6.3).

Impacts of the proposed Swift Creek Chemical Complex upon Swift Creek and the Suwannee River are estimated for phosphate, nitrogen, total organic carbon, fluoride and sulfate. Phosphate, nitrogen and carbon were selected for the calculations because they are the major nutrients which are normally limiting to aquatic organisms and are most likely to cause problems when present in excess. Fluoride and sulfate were chosen because they are closely related to phosphate processing.

Two impact scenarios were examined. Scenario A considers the average estimated composition of nonprocess water (Table 3.2-2). Scenario B considers that the discharge would have the maximum concentrations of phosphate and fluoride allowable under Federal Fertilizer Effluent Guidelines.

Predicted loadings (kg/day) and concentrations (mg/l) were based on a constant 2.4 cfs discharge. Both scenarios considered annual average flow, low flow (M7,2) and very low flow (M7,10) conditions in Swift Creek and the Suwannee River (Table 3.2-3, 3.2-4 and 3.2-5).

The impacts associated with nonprocess water discharge are presented graphically in Figures 3.2-4 and 3.2-5.

3.2.6.2.2 Phosphates

Swift Creek -- For Scenario A, the phosphate concentration will be reduced under all flow conditions, except during peak flow where the concentration remains essentially the same (Table 3.2-3). Thus, nonprocess water from the Swift Creek plant could slightly decrease the present phosphate concentration in Swift Creek. This apparent decrease is indicated because the long-term average phosphate concentration is higher than the estimated phosphate concentrations in the SCCP discharge. The higher levels in Swift Creek may partly be the results of rainfall runoff from old fertilizer spills on the SRCP site. This type of phosphate contribution will not exist at the SCCP since no granular fertilizer will be produced and increased efforts are underway to reduce this type of contamination.

For Scenario B, the largest increase in concentration occurs during very low flow when it increases from 17.7 to 19.3 mg/l, or 9 percent. With average flow, the concentration increases from 15.9 mg/l to 16.7 mg/l, or 5 percent. Impacts due to Scenario B should not be misunderstood. They are worst case impacts and may never happen. Long-term monitoring of nonprocess water discharges indicate that phosphate concentrations seldom exceed the 11 mg/l mean used under Scenario A. Scenario B was only calculated to show that even if phosphate concentrations reached the permit limits of 35 mg/l as a daily average, the relative increases in phosphate levels in Swift Creek would not be extremely high.

Suwannee River -- The impact of increased phosphate loading due to the proposed plant is minimal under average flow. For Scenario A, levels will increase from 0.58 to 0.59 mg/l at Suwannee Springs, or approximately 2 percent. Similar increases will occur at Branford and Wilcox (Table 3.2-5).

The largest impact will occur under Scenario B and very low flow in the Suwannee River (Table 3.2-5). Under these conditions the phosphate levels will increase 1.1 mg/l P over the present levels at Suwannee Springs. At Wilcox, the increase is only 0.02 mg/l P.

The increased phosphate levels in the Suwannee River will not be detected under average or higher than average flow conditions. Sampling variation due to temporal and climatic variations probably cause more variation in phosphate levels in the Suwannee River.

While phosphate levels in Swift Creek and the Suwannee River are high, it is expected that no environmental effect on the aquatic system will result from increased phosphate levels since all concentrations in the streams are already well above the levels limiting to aquatic plants. No reported problems attributable to high phosphate levels in the Suwannee River have been located during the EIS preparation.

3.2.6.2.3 Total Nitrogen

Swift Creek -- A reduction will occur at all locations due to the lack of ammonia at the proposed plant. Based on the estimated nitrogen concentrations of the nonprocess water discharge, a two to five percent reduction in total nitrogen concentrations will occur under all flow conditions (Table

3.2-3). This will greatly decrease the change of unionized ammonia concentrations exceeding the 0.02 mg/l maximum set by FDER.

Suwannee River -- Under average or higher than average flow conditions, total nitrogen concentration will increase a maximum of 0.3 percent (Table 3.2-5). This increase is probably not detectable given sampling and analytical variability.

Under low flow, M(7,10), similar increases will occur at Branford and Wilcox (Table 3.2-5). A 2.7 percent increase will occur at Suwannee Springs under these conditions.

As with phosphate, increased nitrogen concentrations (Table 3.2-5) should not cause eutrophication problems because they are already above the range of concentrations thought to be limiting to aquatic plants. Other factors, such as light penetration of the highly colored waters, mixing, and stream velocity are probably limiting.

FDER does not regulate the concentration of total nitrogen in water although they do regulate the amount of unionized ammonia in Class III waters which will decrease since no ammonia will be used at the Swift Creek plant.

3.2.6.2.4 Fluoride

Swift Creek -- Under Scenario A, fluoride will increase less than 2 percent under all flow conditions, except during peak flow where the concentration remains essentially the same (Table 3.2-3).

With Scenario B, fluoride concentrations will increase 15 percent for average flow conditions and up to 29 percent for the very low flow case (Table 3.2-3). However, the concentrations will remain below the FDER 10 mg/l limit for fluoride in Class III waters.

Suwannee River -- Under Scenario A, fluoride concentrations will increase 2.2, 1.1 and 0.7 percent at Suwannee Springs, Branford and Wilcox, respectively (Table 3.2-5). This represents a maximum increase of 0.01 mg/l F which is minimal.

Concentrations will increase more under Scenario B, but the increased concentrations will not exceed the FDER limit of 1.6 mg/l for drinking water or the 10 mg/l maximum for Class III waters.

3.2.6.2.5 Sulfate

Swift Creek -- The present concentration of sulfate in Swift Creek at average flow is 157 mg/l (Table 3.2-3); the new discharge would increase this to 161 mg/l or 2.5 percent. Under very low flow conditions, the concentration is estimated to increse from 186 to 192 mg/l or 3.2 percent. Occidental deep wells have concentrations as high as 145 mg/l in some cases.

Suwannee River -- For the Suwannee River at Suwannee Springs the sulfate concentration at average flow would increase from 10.3 to 10.6 mg/l or 3 percent. Concentrations downstream will increase even less.

No standards for sulfate in Class III waters exist at the state or federal level. However, a 250 mg/l limit exists for potable waters.

This maximum concentration is not harmful except that it may have a laxative effect for sensitive persons and is established mainly for esthetic reasons (EPA, 1974).

3.2.6.2.6 Total Organic Carbon

Total organic carbon (TOC) is a measure of the concentration of organic matter in water. Relatively high concentrations of TOC occur naturally in the headwaters of Swift Creek and in the Suwannee River as a result of runoff from wetlands and forests. Data in Tables 3.2-3 through 3.2-5 show that concentrations of TOC will decrease slightly as a result of the new discharge, although the mass loadings slightly increase. There will be no detectable impact on the TOC level in the receiving waters. There are no state or federal regulations concerning TOC.

3.2.6.3 Impact of Treated Process Water Discharge

Process water will be treated and discharged when pond water levels infringe upon the surge capacity of the cooling pond (see Section 1.4.2.1.7).

To present the maximum impact from treated process water, it was assumed that both the Suwannee River and the proposed Swift Creek plants will be discharging at the same time. The Suwannee River has a treating facility designed to treat at a maximum rate of 3000 GPM, or 6.7 cfs. The proposed Swift Creek plant facility can treat at a maximum rate of 2000 GPM, or 4.5 cfs. At worst, the treated water will meet the EPA guidlines of 25 mg/l F and 35 mg/l P as a maximum daily average. Using the guideline limits and a 4.5 cfs discharge, approximately 385 kg/day phosphate as P and 275 kg/day of fluoride will be added to Swift Creek from the proposed plant due to treated process discharges. The Suwannee River will add an additional 575 kg/day phosphate as P and 400 kg/day of fluoride due to its treated process water discharge.

These predicted concentrations represent the maximum impact anticipated from the discharge of treated process waters (Table 3.2-6). The actual concentrations of phosphate and fluoride discharged have been and should continue to be lower than the permit limitations (Table 1.4-6). The process water impact will be short-term because of the infrequent nature of these discharges. During the 10 year history of the present Suwannee River plant, treated process waters have been discharged for an aggregate of only four to five months at 1000 GPM.

3.2.6.4 Summary

Minimal changes in concentrations of the chemical parameters of interest are expected in Swift Creek or the Suwannee River as a result of the new discharge. For one parameter, nitrogen, a decrease is predited.

In all cases the concentrations are below guidelines and/or legal limitations.

3.2.7 GROUNDWATER QUALITY

3.2.7.1 Characteristics of Process Water

The possibility for contamination of groundwater aquifers by seepage of process water from the proposed Swift Creek Chemical Complex is examined in this section. Process water from the gypsum stack and cooling pond of a phosphate chemical plant has the poorest water quality of all kinds of waters associated with phosphate mining and processing facilities. Seepage of these waters thus presents the greatest potential for contaminating groundwater supplies. Table 3.2-7 summarizes the chemical characteristics of process waters from the latest water quality sampling at the Suwannee River Chemical Complex operated by Occidental since 1968. Appendix A3.2.1 (Table A3.2-4) presents additional data on these process waters.

In general, process waters have highly acidic pH values (range of 1.3 to 1.7); high levels of specific conductance (hence, of dissolved solids); very high concentrations of phosphate, fluoride, and sulfate (up to 6000 mg/l); high levels of other major ions (except chloride); high levels of iron (up to several hundred mg/l), manganese (5-10 mg/l), and ammonium† (up to 300 mg/l). Arsenic concentrations range from about 0.3 to 0.5 mg/l; chromium levels range from about 1 to 1.5 mg/l; and zinc levels are about 1-3 mg/l. The latter values could be of toxic concern to aquatic organism in surface discharges, but the values are well within the 5 mg/l standard for zinc in drinking water* (Table 3.2-8). Levels of mercury and nitrate are low in the process waters.

3.2.7.2 Seepage From Proposed Gypsum Stack-Cooling Pond Complex

The proposed gypsum stack and cooling pond will be constructed in stages. At start-up, the gypsum stack will be constructed partially within a mined-out area and partially on natural ground (see Figure 3.2-6). Most of the cooling pond will be constructed on natural ground. The remainder of the cooling area will be provided within a deep ditch excavated around the periphery of the gypsum stack to intercept seepage from the stack.

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†Ammonium is present in the process water of the Suwannee River Chemical Complex because diammonium phosphate is being produced at that plant. The proposed Swift Creek Chemical Complex will only be producing superphosphoric acid and, therefore, the source of ammonium present at the Suwannee River Plant will not exist at the proposed Swift Creek Plant.

*It is our understanding that sometime in the past, zinc powder was used at the Suwannee River Granulation Plant to produce a special fertilizer blend. No granulation plant is proposed for the Swift Creek site.

The normal operating level of the below-ground cooling area will be maintained within a few feet of the ground water-table. The level will be maintained by controlling the spillway discharge from the above-ground pond and/or by adding water to the system; e.g., non-process water. Although it is anticipated that there will be periods when groundwater from the surficial aquifer seeps into the below-ground pond, the system will be designed and operated so that, on the average, the level in the below-ground cooling area will be slightly above the ground water-table; i.e., seepage will generally be from the cooling pond into the surficial aquifer. The reason for operating the cooling pond as described is to prevent groundwater seepage from the surficial aquifer from entering the process water system, where it eventually would have to be treated and discharged to surface waters. (Net seepage from the cooling pond was not included in the water balance calculations discussed in Section 1.4). The impact of seepage from the cooling pond into the surficial aquifer is discussed in Sections 3.2.7.4 and 3.2.7.5.

Occidental plans to mine the area adjacent to the Stage I gypsum stack and use the mined-out area for a below-ground cooling pond and for future expansion of the gypsum stack (see Alternate 1, Figure 3.2-6). The below-ground cooling pond during this later stage in the development of the stack will also be designed and operated to maintain the normal pond level slightly above the ground water-table. The water level will be maintained by controlling the amount of water stored on the gypsum stack and/or by adding water to the system.

If the area is not mined, the remainder of the gypsum stack will be constructed on natural ground as shown in Alternate 2 on Figure 3.2-6. If this alternate is used, an interceptor ditch will be constructed around the outer periphery of the above-ground cooling pond as well as around the above-ground portions of the gypsum stack.

Since the permeability of the gypsum is 3 to 4 orders of magnitude higher than the vertical permeability of the confining beds overlying the Floridan Aquifer, most of the seepage from the gypsum stack will flow into the adjacent below-ground cooling pond or interceptor ditch. However, because of the head difference between the surficial aquifer and the Floridan Aquifer, some contaminated water from the cooling pond-gypsum stack complex will migrate downward at a very slow rate. The impacts on water quality in the Floridan Aquifer are discussed in Section 3.2.7.6.

3.2.7.3 Observation Well Network at Suwannee River Plant

To examine the possible impacts of process water seepage from the new plant on groundwater quality, a network of 22 monitoring wells was installed at varying depths and distances from two existing gypsum stacks and cooling ponds at the Suwannee River Chemical Plant, which is located in the same hydrogeologic setting as the proposed Swift Creek Chemical Plant.

Four sets of observation wells were located on a line running west, downgradient of the Dorr Oliver Gypsum Stack (Stack No. 1 in Figure 3.2-7). This stack has been in operation for over 10 years, thus providing ample time for seepage to occur. Four wells of varying depth were installed in each of the four well sets (Sets 3, 4, 5, and 6). Within each set, wells were labeled "A," "B," "C," and "D" in order of increasing depth of collection zone. "A" wells were located in the surficial sands (<10 feet deep); "B" wells were generally installed in the water-bearing zone of the upper Hawthorn Formation; i.e., in the ore matrix (which comprises the lower portion of the surficial aquifer); and Wells "C" and "D" were located at increasing depths in the Hawthorn confining unit, the "D" wells being near the top of the Floridan Aquifer. Figure 3.2-8 shows the location and depth of the wells in relation to the existing stack, cooling pond, and other features of the Suwannee River Chemical Plant. Boring logs and individual well characteristics are presented in Figure 3.2-9.

The Dorr Oliver gypsum stack is founded in a mined-out pit, and the acid surge pond south of the stack is also located in a mined-out area (Figure 3.2-7). Well Set 6 was installed near the southwest corner of the stack, approximately 100 feet from the surge pond which, at this location, lies on natural ground immediately adjacent to the stack. Liming Pond No. 1 (First Stage Treatment) lies in a mined-out area southwest of Set 6. (The quality of water in this pond is still highly acidic, as shown in Table A3.2-5 of Appendix A3.2.1). Set 5 was installed about 900 feet west of Set 6, and approximately 400 feet east of an above-ground cooling pond (Cooling Pond No. 1 in Figures 3.2-7 and 3.2-8); Set 4 was about 2300 feet further west (and about 600 feet west of the cooling pond), and Set 3 was located about 1100 feet further west of Set 4.

Because of the existing hydraulic gradients, Set 6 should represent the "worst case" scenario of seepage from the gypsum stack and acid surge pond (Figure 3.2-8). The Dorr Oliver gypsum stack is located in a mined-out area and is not surrounded by a below-ground cooling pond.

Consequently, the pressure head acting against the edge of the mined-out pit can be as high as the elevation of the gypsum stack at that location. With a below-ground cooling pond, the corresponding pressure head cannot be higher than the pond elevation. Hence, the quantity of seepage and the potential for contamination of the surficial aquifer at the Dorr Oliver Stack would be greater than for the proposed stack.

In addition, two sets of monitoring wells (Sets 1 and 2) were placed near Cooling Pond No. 2 downgradient of the CTC gypsum stack (No. 2 in Figures 3.2-7 and 3.2-8) at the Suwannee River Plant. This "new" stack has been in operation for about 2 years. The eastern portion of the CTC cooling pond-gypsum stack (where the wells are located) is constructed on natural ground. Only the western quarter portion of this stack lies in a mined-out area. Well Set 2 was located at the outer edge of the retaining dike just west of the cooling pond of Stack No. 2, and Well Set No. 1 was located about 100 feet further west. Three wells of varying depths were installed in each of Well Sets 1 and 2, as shown in Figures 3.2-8 and 3.2-9.

All observation wells were rotary drilled to the desired elevation. The nominal diameter of these wells was 4 inches. A minimum 1-foot thick layer of silica sand was tremie-packed at the bottom of the hole (see

Figure 3.2-9). A 2-inch slotted PVC pipe surrounded by silica sand formed the collection zone of these wells. The silica sand extended a few feet above the collection zone and was overlain by a bentonite-cement grout seal that extended to ground surface.

All 22 wells were flushed, primed and developed after installation using water from production wells tapping the Floridan Aquifer. Each observation well was sampled 4 times beginning in January 1978. Prior to the first sampling, a volume of water equivalent to the full volume of the well was pumped out. Nevertheless, the first set of sampling (Sample Set "W") did not fully reflect ambient groundwater conditions, as exhibited in Table A3.2-1 (Appendix A3.2.1). The wells were again sampled two to four weeks after the first sampling date (Sample Set "X"). The latest two water quality samples were taken on the same day in April, 1978: one prior to pumping the wells (Sample Set "Y") and one immediately following pumping a full volume of the well (Sample Set "Z"). This was done because of the existing controversy about well sampling. For instance, it is generally accepted practice to pump a well prior to sampling. However, when this is done in the vicinity of an existing facility (such as a gypsum stack), pumping a well may result in reversing the gradient for water flow in at least one direction, hence causing dilution of the groundwater quality in the well vicinity.

The last three water quality samples ("X," "Y," and "Z") did not exhibit, however, significant differences or consistent trends in water quality parameters and, therefore, are considered representative of ambient groundwater conditions.

3.2.7.4 Results of Groundwater Monitoring Study at the Suwannee River Plant

In addition to the observation wells installed specifically for this study, 12 existing Floridan Aquifer water supply wells at the Suwannee River Beneficiation and Chemical Plants were sampled (see Figure 3.2-7), and chemical analyses were done on the samples. In addition, process waters and various other waters were also sampled at the locations shown in Figure 3.2-7, for comparative purposes.

All available results for the observation wells, water supply wells and process waters at the Suwannee River Plant are listed in Appendix A3.2.1, along with information on depth of collection zone, water level elevation, and sampling date. Table 3.2-9 summarizes the observation well results from the last sampling set which is representative of ambient groundwater conditions.

Figures 3.2-10 to 3.2-19 show the ranges of concentrations measured in the observation wells at the Suwannee River Chemical Plant. To visualize the impact of the existing plant, concentrations are plotted as functions of both depth and distance from the gypsum stack and cooling pond. Graphs are presented for the following important water quality parameters: phosphate, fluoride, sulfate, pH, conductance, nitrate, ammonium, gross alpha radiation and radium-226*. For reasons detailed in Section 2.6.5, sulfate, calcium and total hardness data (as well as some pH and conductivity data) from the first sampling set were not considered in graphing the concentration profiles since these are not representative of ambient groundwater conditions.

The results presented in Figures 3.2-10 through 3.2-19 indicate that the gypsum stack and cooling pond have caused only localized contamination of the surficial aquifer and the upper layer of the Hawthorn Formation.

Concentrations of most parameters were high (and pH was low) in shallow Well 6A and Well 6B, which were closest to the Dorr Oliver Gypsum Stack (No. 1). The concentration of fluoride was lower in Well 6B, but ortho and total phosphate, conductivity, sulfate and ammonium concentrations were all high in both wells. The higher concentrations of phosphate in Well 6B probably reflect the fact that the collection zone for this well is within the phosphate matrix zone. It is important to note that because of precipitation, adsorption and dilution, fluoride levels declined to background levels in Well 6B (Figure 3.2-10). The chemical composition of water from Wells 6C and 6D was similar and all concentrations were at background levels.

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*Section 3.5 discusses the radio-chemical data.

There is evidence for only slight contamination of the surficial aquifer downgradient from Well 6A. All parameters in Well 5A decreased significantly in concentrations (and pH increased) from those found in Well 6A, indicating the localized nature of the contamination of the aquifer near the gypsum stack. Specific conductivity (Figure 3.2-15) was slightly above background levels in Well 5A, but at background in Wells 4A to 1A. Sulfate levels (Figure 3.2-11) were above background (of 5 to 20 mg/1) in Well 5A (concentrations were around 80 mg/1), but background levels were found in the other shallow wells, including those from Sets 1 and 2 near Stack No. 2. Fluoride levels (Figure 3.2-10) dropped to background levels at Well 5A and remained low in the rest of the transect. A relatively high concentration of fluoride was found in Well 2A adjacent to Stack No. 2, but Figure 3.2-10 clearly indicates that transport of fluoride is very limited in these soils, since the fluoride level in Well 1A, 100 feet away, was down to background levels.

Total phosphate concentrations (Figure 3.2-14) were relatively high throughout the A series of wells and orthophosphate (Figure 3.2-13) constituted less than half the total. These results (with the exception of Well 6A) suggest that the high values for total phosphate reflect the presence of turbidity in the well samples rather than the transport of dissolved phosphate from the stack. The concentration profile for orthophosphate from Well 5A to Well 1A is within the background range found for the surficial aquifer at the Swift Creek site.

Ammonium levels in Well 5A (Figure 3.2-16) were less than one-half the values found in Well 6A, and the rest of the surface wells had concentrations in the background range. The profile for nitrate (Figure 3.2-17) is quite different than that for other species. Essentially no nitrate was found in Wells 5A and 6A, and a peak of about 1 mg/l occurred in Well 4A. Evidently, nitrification of ammonium is occurring after Set 5, and the more mobile nitrate is being transported downgradient.

Similar horizontal trends in concentrations of the various ions occurred within Collection Zone B (15 to 50 feet deep), which again reveals the localized nature of contamination from the gypsum stack. Contamination from the stack was evident in Well 6B in that all important indicators of contamination, except fluoride, had elevated concentrations. Concentrations of all indicators were down to background by Well 4B. In general, the declines in concentration from Well 6B to 5B were less precipitous than those for Well 6A to 5A indicating lateral movement of seepage from the stack. The concentration of nitrate (Figure 3.2-17) showed a sharp peak in Well 5B and the concentration measured on the last sample collected from this well (11.5 mg/l) slightly exceeded the drinking water standard of 10 mg/l.

Concentrations of all substances were at background levels in all C wells (except for sulfate in Well 5C) and all D series wells (collection zones from 70 to 140 feet). Sulfate is a parameter not subject to attenuation, precipitation or adsorption within the geohydrologic environment found at the site. Thus, the elevated levels of sulfate in Well 5C as compared to 6C seem to indicate that seepage from the stack is horizontal through Zone B, but essentially above the plastic clay confining unit. Some of the seepage seems then to migrate downward as indicated by the high sulfate level in Well 5C. However, it is important to note that concentrations in Well 5D (and, in all other wells sampled from Zones C and D) were at background levels, again demonstrating the localized nature of the seepage from the gypsum stack. There is no evidence for the transport of any contaminants from the gypsum stacks or cooling ponds down to the lower depths in the Hawthorn Formation.

Figures 3.2-20 to 3.2-23 are concentration versus depth profiles for the various constituents discussed above. The ranges of concentration found in the Swift Creek observation wells are presented as bands on these figures, and can be considered as background levels because no chemical plant is present at the Swift Creek site. The data points represent measured concentrations for the observation wells at the Suwannee River Chemical Plant. These figures further substantiate the points made in the discussion above.

In summary, the monitoring data for observation wells at the Suwannee River Plant indicate that contamination of groundwater by seepage from the existing gypsum stacks and cooling ponds has been limited in depth to just below the top zone of the Hawthorn Formation (15 to 50 feet deep) during the 10 years that the pond and stack have been utilized. Within the sandy surficial aquifer and the surficial zone of the Hawthorn Formation, contamination is limited horizontally to a distance of about one thousand feet (for most parameters) and possibly less than 1000 feet, since there are no intermediate wells available to check on the rate of decay from Set 6 to Set 5. It should be noted that the concentrations at distances of 1000 to 3000 feet from the stack also reflect seepage from the nearby above-ground cooling pond. There is no evidence to support any contention of long-range contamination of surficial aquifers, except in localized areas near the gypsum stack-cooling pond, and no evidence to indicate that the lower (artesian) aquifers of the Hawthorn Formation are anywhere contaminated by seepage of process water from the Suwannee River Chemical Plant. Furthermore, the shapes of the profiles of concentration versus distance from Stack No. 1 and the cooling pond clearly indicate that the gypsum stack rather than the cooling pond is the major source of the limited and localized zone of contamination that does occur at the Suwannee River Plant.

The monitoring program conducted at the Suwannee River Chemical Plant does not necessarily indicate that, if the gypsum stack is located in a mined-out area it would result in more extensive contamination than if the stack is founded on natural ground. The Dorr Oliver gypsum stack, which is located in a mined-out area, has been in operation for more than 10 years thus providing time for seepage to occur, and is a "mature" stack subjecting the surrounding area to high seepage gradients. On the other hand, the CTC stack, which for the most part is founded on natural ground, is only 2 years old and is still relatively very low. Hence, although the monitoring program indicates a significantly more localized zone of contamination at the CTC stack, one cannot draw the conclusion that this is due to this stack being founded on natural grade or that the "semi-confining" bed found within the surficial aquifer is effective in reducing seepage, because there are other overriding factors such as the height and age of the stack. It should be noted that the semi-confining bed in the surficial aquifer is relatively pervious compared to the underlying Hawthorn confining unit and is, therefore, ineffective in reducing downward seepage (Section 2.6.3.2). However, because of its clay content, the semi-confining bed will provide a certain degree of attenuation of some contaminants seeping out of an above-ground gypsum stack, both in the vertical and horizontal directions.

3.2.7.5 Impacts of Swift Creek Chemical Plant on Groundwater Quality in the Surficial Aquifer and Hawthorn Formation

The study described in the preceding section and the fact that the geology at the proposed Swift Creek Plant site is essentially the same as that at the Suwannee River Plant, allow one to conclude that the impacts of the proposed Swift Creek Chemical Plant on groundwater quality in the surficial aquifer and Hawthorn Formation will be limited to a relatively small area and depth immediately around the proposed gypsum stack-cooling pond. Impact should be limited to the surficial zone of the Hawthorn Formation (maximum depth of about 50 feet) and should not extend to the lower zones of the Hawthorn Formation. Horizontally, impact should be limited to a distance of less than 1000 feet from the gypsum stack, and thus will be confined to the property of Occidental Chemical Company. Within the zone of impact, lower levels of pH and elevated levels of fluoride, phosphate, sulfate, calcium, and sodium are expected, but, except at very short distances from the stack, all ions will have concentrations within the range found in the Floridan Aquifer.

Since diammonium phosphate will not be produced at the Swift Creek Plant, there should be no impact of groundwater from ammonium, and consequently no elevated levels of nitrate as a result of nitrification of ammonium within the soil.

Impact of groundwater at the Swift Creek Plan should be even more localized than that observed from the Dorr-Oliver Gypsum Stack at the Suwannee River Plant, since the latter stack was not designed to minimize seepage; i.e., the outer periphery of the Dorr-Oliver Stack (see cross-section in Figure 3.2-8), is not excavated to provide the sump effect shown in Figure 3.2-6 for the proposed stack. Hence, the quantity of seepage and the potential for contamination from the Dorr Oliver Stack (particularly at the location of Well Set 6) would be significantly higher than that from the below-ground pond surrounding the proposed stack (Section 3.2.7.3).

3.2.7.6 Impacts of the Swift Creek Chemical Plant on Water Quality in the Floridan Aquifer

Because of the head difference between the surficial aquifer and the Floridan Aquifer, some contaminated water from the cooling pond-gypsum stack complex will migrate downward to the Floridan Aquifer. However, due to the low permeability of the confining units underlying the complex, downward migration of the contaminants will progress at a very slow rate (Section 2.6.3.3). During this very slow migration, some of the specific ions, such as phosphorus, will be precipitated and/or adsorbed by the clay minerals comprising the confining units. Other ions, such as fluoride, will be attenuated to a large degree through adsorption by clay minerals and chemical reactions with calcareous formations. Still other ions, such as sulfate, will be more or less unaffected during the downward migration of the contaminated water. Any process water which may reach the Floridan Aquifer would further be greatly dispersed by the lateral movement of water in the aquifer, thus further decreasing the potential for a change in the water quality of the aquifer.

The semi-confining bed within the surficial aquifer is too pervious (Section 2.6.3.2) compared to the Hawthorn confining unit to significantly reduce the amount of downward seepage. However, this layer, because of its clay content, would provide a certain degree of attenuation of some contaminants seeping out of an above-ground gypsum stack and above-ground cooling pond.

The proposed plant is not predicted to have any effects on water quality in the Floridan Aquifer. This conclusion is based on examination of water quality analyses performed on supply wells at the Suwannee River Chemical and Beneficiation Plants (see locations in Figure 3.2-7). Appendix A3.2.1 summarizes all available water quality data from Occidental potable and production wells (Tables A3.2-2 and A3.2-3), and lists historical water quality data extending back to 1968 on Well M-1 (collection zone of 180 to 1265 feet below land surface) and Well C-1 (collection zone 189 to 803 feet deep).

The 11 available sets of analyses for Well M-1 and C-1 indicate no monotonic trends in concentrations of major ions over the period of record. Unfortunately, the number of parameters for which long-term data are available is limited. These parameters are plotted in Figure 3.2-24. Although some variations exist over the period of record due to "seasonal" changes in water quality, no monotonic trends are observed, particularly when one takes into consideration the different sampling laboratories (and possibly differing methods of chemical analysis) over the period of record. The concentrations observed in 1978 in the latest sampling are generally well within the range observed in earlier sampling (1968 to 1972).

Complete sets of water quality data on these wells are limited to those done in 1978 as part of the present study. These recent analyses indicate that the quality from the deep production wells is good, and the waters meet all applicable drinking water standards except for iron. Concentrations of iron sometimes exceed the drinking water standard of 0.3 mg/l, but this is relatively common in well waters of this area and the iron levels are not likely to be related to phosphate mining or processing activities.

Tables 3.2-10 and 3.2-11 compare the chemical composition of various potable and production wells at the Suwannee River Chemical Plant to potable and production wells already in existence at the Swift Creek site, as obtained from the latest sampling. Additional data is presented in Appendices A2.6.1 (Section 2.6) and A3.2.1. The collection zones for the potable wells range from the lower Hawthorn Formation to Ocala limestone of the Floridan Aquifer, but in all cases, the deep production wells tap the Floridan Aquifer. No differences in chemical composition can be discerned between the two sites, and the waters are all of good quality (except for high iron). There is no evidence for contamination of the water supply wells by process water from the Suwannee River Chemical Plant. As shown in Table 3.2-12, the analyses from the Suwannee River Plant supply wells compare favorably with those at the Swift Creek site and with regional data. Only four parameters show a slightly higher range in concentration in wells at the Suwannee River Plant, but this is probably due to the significantly larger number of samples available from these wells.

Steady state seepage to the Floridan Aquifer is not expected to occur over the life of the proposed plant. Even if one assumes steady state seepage, water entering the Floridan Aquifer would be greatly dispersed by the lateral movement of water in the aquifer. Under steady state seepage, adsorption by clay minerals and reactions with calcareous formations will substantially improve the quality of the water seeping to the Floridan Aquifer. Even if this is not taken into account, the chemical constituents of the water infiltrating the Hawthorn Formation from the surficial aquifer will be diluted to concentrations less than 5 percent upon reaching the Floridan Aquifer directly under the chemical complex. This scenario is, however, hypothetical and will not occur, as evidenced by the above discussion based on the historical and monitoring records.

In summary, analyses from numerous wells that collect water from all levels of the Floridan Aquifer at the existing Suwannee River Chemical Plant and (for comparison) at the proposed Swift Creek site indicate no contamination of the Floridan Aquifer by the existing plant. Therefore, the proposed plant is predicted to have no impact on the water quality of the Floridan Aquifer.

In addition, the possibility of upward movement by leakage of high sulfate water from greater depths due to the proposed 3.76 MGD withdrawals from the Floridan Aquifer is remote, and would be confined to the immediate vicinity of the pump well, if it were to occur. Once pumping is terminated, any potential impact would be mitigated. Current Occidental production wells at the site indicate that the levels of sulfate are well within typical regional concentrations, and historical records from these wells do not reveal monotonic trends. Hence, no upconing is predicted as a result of the proposed pumping from the Swift Creek Chemical Plant.

3.2.8 IMPACTS FROM ACCIDENTS AND SPILLS

The gypsum stack-cooling pond complex will be designed in accordance with State-of-the-Art practices. Although the site is not susceptible to damaging earthquakes, the design will comply with requirements of Earthquake Zone 1 (Section 2.4.5).

The probability of having a spill of the ponded water on top of the stack (as a result of an unlikely high magnitude earthquake, for instance) is very low. Nevertheless, the cooling pond surrounding the gypsum stack has enough surge capacity to fully contain the maximum estimate of about 100 acre-feet of acid water that may be stored on top of the stack. Such a spill will cause a rise in the water level of the cooling pond that will not exceed one foot (and more than likely, will be on the order of 0.5 feet). This is well within the available surge. Hence, in the unlikely event of a spill, acid water will be contained within the system. The spill will not cause the gypsum to wash out because of its self-cementing characteristics.

The gypsum stack has a very low probability of failure because gypsum cements itself (Wissa, 1977). Hence, the probability of liquefaction due to earthquake shaking is low. However, even when liquified, gypsum is one of the most "forgiving" materials as it dilates and will not flow for long distances (approximately 1000 feet or so). In this unlikely event, however, approximately fifty percent of the ponded water on top of the stack (≈50 acre-feet) could find its way to surface water courses and subsequently to groundwater supplies. The effects on surface waters may be significant but will mitigate with time. Impacts on groundwater will not be as significant since the process water will react with the soil and will get neutralized as it percolates to the Floridan Aquifer. The impacts from a spill have not been extensively analyzed because the probability of such an occurrence is extremely low.

Table 3.2-1 Estimated Concentrations and Mass Loads from Nonprocess Discharges of Proposed Swift Creek Phosphate Plant

Parameter	Estimated Average Concentration (mg/1)	Estimated Mass Loading (kg/day) in 2.4 cfs of Discharge
pH	6.0	--
Total P	11.0	64.6
Ammonium-N	1.0	5.9
Nitrate-N	0.9	5.3
Organic-N	0.5	2.9
Total N	2.4	14.1
TOC	9.3	54.6
Sulfate	250	1470
Fluoride	7.2	42.3
Calcium	58	341
Sodium	65	382
NPDES Permit Limitations:		
Total P	35	206
Fluoride	25	147

Table 3.2-2 Effluent Quality Produced by Two-stage Limestone-Lime Treatment

Analysis(1)	Process Water	Stage II Supernatant
pH, Std. Units	1.70	9.0
Acidity, as $CaCO_3$	32,800	-
Fluoride, as F	6,600	12-20
Total P	4,000	1-13
Total Suspended Solids	69	15
Chlorides, as Cl	72	75
Sulfates, as SO_4	6,200	2,709
Sodium as Na	896	900
Calcium, as Ca	77	375
Magnesium, as Mg	44	22
Aluminum, as Al	389	<0.2
Chrome, as Cr	0.43	<0.10
Zinc	1.46	<0.10
Iron, as Fe	263	0.10
Manganese, as Mn	7.9	0.03
Boron, as B	0.90	<0.50
Lead, as Pb	<0.10	<0.10

(1) All values in mg/l unless otherwise noted.

Table 3.2-3 Mass Loading and Concentrations at Mouth of Swift Creek Under Present Conditions and with Added Discharge from Swift Creek Chemical Plant Nonprocess Water

PARAMETER	MASS LOADINGS AT AVERAGE FLOW IN kg/day		
	Present Loading*	Predicted Loading With New Source	Percent Change
Total P (Predicted)	2300	2365	2.8
(NPDES Limit)	2300	2506	9.0
Total N	1160	1174	1.2
Fluoride (Predicted)	766	808	5.5
(NPDES Limit)	766	913	19.2
Sulfate	21700	23170	6.7
TOC	2760	2815	2.0
Calcium	6640	6981	5.1
Sodium	4180	4562	9.1

PARAMETER	CONCENTRATIONS FOR VARYING FLOW CONDITIONS IN mg/l							
	Average Flow		M(7,2) Low Flow		M(7,10) Low Flow		5-Year Peak Flow	
	Present	With New Source	Present	With *** New Source	Present	With *** New Source	Present	With New Source
Total P (Predicted)	15.9	15.7	17.4	17.0	17.7	17.2	10.8	10.8
(NPDES Limit)	15.9	16.7	17.4	18.5	17.7	18.9	10.8	10.8
Total N	8.0	7.8	8.9	8.5	9.2	8.7	5.2	5.2
Fluoride (Predicted)	5.3	5.4	5.8	5.9	5.9	6.0	3.7	3.7
(NPDES Limit)	5.3	6.1	5.8	7.0	5.9	7.3	3.7	3.7
Sulfate	157	161	179	183	186	191	69	69.3
TOC	19.1	18.7	16.1	15.2	15.5	15.0	41.4	41.4
Calcium**	46	46.5	--	--	--	--	--	--
Sodium**	29	30.4	--	--	--	--	--	--

*Based on average flow and corresponding regression value for concentration.

**Regression relation between flow and concentrations of these parameters are unavailable at this time.

***Assumes all the non-process discharge will be discharged during periods of low flow. Long-term record indicates discharge during M(7,2) and M(7,10) are 40% and 27% of average discharge, respectively.

Table 3.2-4 Mass Loadings and Concentrations Along the Suwannee River Below Swift Creek Under Present Conditions and with Added Discharge from Swift Creek Chemical Plant Nonprocess Water

MASS LOADINGS IN kg/day AT AVERAGE FLOW

Parameter	Suwannee Springs			Branford			Wilcox		
	Present	With New Source	Percent Change	Present	With New Source	Percent Change	Present	With New Source	Percent Change
Total P (Predicted)	2950	2915	2.3	3340	3405	1.9	3825	3890	1.7
(EPA Guidelines)	2850	3056	7.2	3340	3546	6.2	3825	4031	5.4
Total N	4720	4734	0.3	10000	10014	0.1	12460	12474	0.1
Fluoride (Predicted)	1900	1942	2.2	3920	3962	1.1	5760	5802	0.7
(EPA Guidelines)	1900	2047	7.7	3920	4067	3.8	5760	5907	2.6
Sulfate	50300	51770	2.9	147000	148470	1.0	294000	295470	0.5
TOC	139000	139055	0.04	212000	212055	0.03	267000	267055	0.02

MASS LOADINGS IN kg/day AT M(7,2) LOW FLOW

Parameter	Suwannee Springs			Branford			Wilcox		
	Present	With New Source	Percent Change	Present	With New Source	Percent Change	Present	With New Source	Percent Change
Total P (Predicted)	880	945	7.4	1450	1515	4.5	1870	1935	3.5
(EPA Guidlines)	880	1086	23.4	1450	1656	14.2	1870	2076	11.0
Total N	728	742	1.9	5342	5356	0.3	12430	12440	0.1
Fluoride (Predicted)	194	236	21.6	1230	1272	3.4	2910	2952	1.4
(EPA Guidelines)	194	341	76.0	1230	1377	12.0	2910	3057	5.1
Sulfate	7320	8790	20.0	104000	105470	1.4	279000	280470	0.5
TOC	5990	6045	0.9	39400	39455	0.1	85200	85255	0.1

MASS LOADINGS IN kg/day AT M(7,10) LOW FLOW

Parameter	Suwannee Springs			Branford			Wilcox		
	Present	With New Source	Percent Change	Present	With New Source	Percent Change	Present	With New Source	Percent Change
Total P (Predicted)	618	683	9.5	1110	1175	5.5	1370	1435	4.5
(EPA Guidelines)	618	824	25.0	1110	1316	15.7	1370	1576	13.1
Total N	503	517	2.7	5489	5503	0.25	13500	13514	0.10
Fluoride (Predicted)	98	140	30.0	848	890	4.7	2170	2212	1.9
(EPA Guidelines)	98	245	60.0	848	995	14.8	2170	2317	6.3
Sulfate	4080	5550	26.5	93100	94570	1.6	273000	274470	0.53
TOC	2330	2385	2.3	22100	22155	0.3	52500	52555	0.10

Table 3.2-5 Concentrations Along the Suwannee River Below Swift Creek Under Present Conditions and with Added Discharge from Swift Creek Chemical Nonprocess Water

CONCENTRATIONS IN mg/l FOR VARYING FLOW CONDITIONS FOR SUWANNEE SPRINGS STATION

Parameter	Average Flow		M(7,2) Flow		M(7,10) Flow	
	Present	With New Source	Present	With New Source	Present	With New Source
Total P (Predicted)	.576	.588	2.50	2.60	3.89	4.14
(NPDES Limit)	.576	.620	2.50	3.03	3.89	4.99
Total N	.956	.958	2.06	2.06	3.36	3.32
Fluoride (Predicted)	.386	.394	0.55	0.66	.615	.849
(NPDES Limit)	.386	.415	0.55	0.96	.615	1.48
Sulfate	10.3	10.6	20.8	24.60	25.7	33.7
TOC	28.1	28.1	17.0	16.90	14.6	14.4

CONCENTRATIONS IN mg/l FOR VARYING FLOW CONDITIONS AT BRANFORD

Parameter	Average Flow		M(7,2)		M(7,10)	
	Present	With New Source	Present	With New Source	Present	With New Source
Total P (Predicted)	0.196	.199	.251	.261	.271	.286
(NPDES Limit)	0.196	.209	.251	.286	.271	.321
Total N	0.587	.589	.923	.925	1.28	1.28
Fluoride (Predicted)	0.231	.232	.212	.219	.208	.217
(NPDES Limit)	0.231	.239	.212	.238	.208	.243
Sulfate	8.64	8.72	18.0	18.2	22.8	2[illegible].1
TOC	12.5	12.5	6.81	6.81	5.40	5.41

CONCENTRATIONS IN mg/l FOR VARYING FLOW CONDITIONS AT WILCOX

Parameter	Average Flow		M(7,2)		M(7,10)	
	Present	With New Source	Present	With New Source	Present	With New Source
Total P (Predicted)	.157	.159	.154	.159	.152	.159
(NPDES Limit)	.157	.166	.154	.171	.152	.176
Total N	.510	.512	1.02	1.02	1.55	1.55
Fluoride (Predicted)	.236	.238	.239	.243	.241	.246
(NPDES Limit)	.236	.242	.239	.251	.241	.258
Sulfate	12.0	12.1	23.0	23.1	30.3	30.5
TOC	10.9	10.9	7.01	7.01	5.83	5.83

Table 3.2-6 Predicted Increases in Phosphate and Fluoride Concentrations in Swift Creek and the Suwannee River due to the Discharge of Treated Process Water from SCCC

Parameter	Baseline Concentration* (mg/l)	Concentration after Addition of Treated Process Water (mg/l)	Increase (mg/l)	Percent Change (%)
		Swift Creek		
Phosphate as P	17.6	18.7	1.1	6.1
Fluoride	7.3	8.4	1.1	15.0
		Suwannee River at Suwannee Springs		
Phosphate as P	0.71	0.79	0.08	11.3
Fluoride	0.47	0.52	0.05	10.6
		Suwannee River at Wilcox		
Phosphate as P	0.18	0.20	0.02	8.7
Fluoride	0.26	0.27	0.01	4.0

*Assumes the following flows - Swift Creek base flow plus SRCC nonprocess water 59 cfs; SRCC treated process water 6.7 cfs; SCCC nonprocess waters 2.4 cfs.

TABLE 3.2-7

WATER QUALITY DATA
SUWANNEE RIVER CHEMICAL PLANT
PROCESS WATERS

	Gypsum Stack	Cooling Ponds		Stage I Liming Pond
Sample Location	GS-1	CP-1	CP-2	LP-1
Date Sampled	4/18/78	4/18/78	4/18/78	4/18/78
Sample Number	9369	9370	9360	9367
Temperature °C	22.7	26	23	26
Color (APHA Units)	110	120	100	50
pH (Field)	--	--	--	--
(Lab)	1.7	1.6	1.6	3.2
NUTRIENTS, mg/l				
Nitrogen-N				
Ammonium	205	299	326	115
Nitrate	<0.005	<0.005	<0.005	0.272
Organic Dissolved	2.8	3.6	25.76	-
Phosphates-P				
Ortho	4200	22.0	200	22.6
Total Phosphorus	6200	4810	3380	2090
Dissolved Organic Carbon	74.5	70.5	57.5	35.5
MAJOR CONSTITUENTS, mg/l				
Iron	220	120	110	4.0
Calcium	550	345	366	1120
Magnesium	155	164	144	148
Sodium	897	914	1380	707
Potassium	190	205	248	91
Sulfate	4340	4720	5540	2580
Sulfides	0.13	0.13	0.27	2.60
Chloride	63	70	51	42
Fluoride	3850	2100	2200	410
Strontium	1.89	1.89	1.95	0.87
Dissolved Solids	28100	30300	26100	13800
Total Solids	28300	30400	26300	13900
Hardness (Total)	2010	1540	1510	3410
Alkalinity ($CaCO_3$)	0	0	0	0
Conductivity (μmhos/cm @ 25°C)	21900	23300	26100	7600
TRACE METALS, mg/l				
Arsenic	0.33	0.38	0.50	0.19
Chromium	1.44	1.14	0.90	0.29
Manganese	9.2	5.9	5.05	6.14
Mercury	<0.0002	0.0004	0.0002	<0.0002
Zinc	2.8	2.4	1.20	1.5

All values are from latest sampling date.
Locations shown in Figure 3.2-7.

TABLE 3.2-8

DRINKING WATER STANDARDS

Parameter	USPHS (1962)	EPA Primary Standards
Arsenic	0.01 mg/l	0.05 mg/l
Barium	--	1.0 mg/l
Cadmium	--	0.01 mg/l
Carbon Chloroform Extract	0.2 mg/l	0.7 mg/l
Chloride	250 mg/l	--
Chromium	--	0.05 mg/l
Color	15 PCU	--
Copper	1.0 mg/l	--
Cyanide	0.01 mg/l	0.2 mg/l
Fluoride	1.3 mg/l	1.4-2.4 mg/l
Iron	0.3 mg/l	--
Lead	--	0.05 mg/l
Manganese	0.05 mg/l	--
Mercury	--	0.002 mg/l
Nitrate	10 mg/l	10 mg/l
Phenols	0.001 mg/l	--
Selenium	--	0.01 mg/l
Silver	--	0.05 mg/l
Solids (Dissolved)	500 mg/l	--
Sulfate	250 mg/l	--
Turbidity	5 NTU	5 NTU (1 NTU Desirable)
Zinc	5 mg/l	--

TABLE 3.2-9

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELLS

	Observation Well Set 1			Observation Well Set 2			Observation Well Set 3			
Well Number	1-A	1-B	1-C	2-A	2-B	2-C	3-A	3-B	3-C	3-D
Depth of Collection Zone	1-11'	13-38'	107-129'	2-13'	20-49'	117-144'	1-11'	15-43'	72-88'	93-120'
Date Sampled	4/18/78	4/18/78	4/18/78	4/18/78	4/17/78	4/17/78	4/13/78	4/13/78	4/13/78	4/13/78
Water Level Elevation	125.4	126.2	62.4	126.1	127.2	65.7	126.3	126.0	67.2	64.4
Sample Number	9355	9357	9359	9353	9350	9352	9280	9282	9284	9286
Temperature °C	--	--	--	22	--	--	--	--	21	20
Color (APHA Units)	2	0	0	7	1	1	5	0	2	2
pH (Field)	--	--	--	--	--	--	--	--	--	--
(Lab)	5.9	7.2	8.9	5.0	7.7	7.7	5.9	7.2	9.6	9.0
NUTRIENTS mg/l										
Nitrogen-N										
Ammonium	0.24	<0.02	0.12	0.22	<0.02	<0.02	0.14	0.05	0.09	0.09
Nitrate	0.038	5.50	0.020	0.007	1.16	0.023	0.022	0.010	<0.005	<0.005
Organic Dissolved	0.18	<0.02	0.22	0.10	0.10	<0.02	0.11	0.08	0.09	0.08
Phosphates-P										
Ortho	0.204	0.460	0.116	0.153	0.387	0.368	0.933	1.51	0.913	0.20
Total Phosphorus	0.58	0.51	0.17	1.35	0.43	0.51	2.30	1.92	1.07	0.20
Dissolved Organic Carbon	9.0	4.0	5.5	5.5	3.5	2.5	9.0	4.5	6.5	5.0
MAJOR CONSTITUENTS, mg/l										
Iron	0.51	0.09	0.20	18.0	0.46	0.41	4.3	0.65	0.48	0.44
Calcium	2.1	10.6	13.7	4.6	14.4	17.0	8.7	22.4	12.5	14.4
Magnesium	1.1	14.6	8.0	1.9	13.2	15.3	2.8	18.3	10.8	8.9
Sodium	3.9	15.4	9.7	5.5	5.5	6.2	9.0	4.1	18.2	10.1
Potassium	0.72	0.90	4.66	0.48	0.36	0.40	0.60	0.72	8.6	1.67
Sulfate	4.4	2.2	8.5	10.0	3.6	4.7	21	4.4	<1.0	7.6
Sulfides	<0.02	<0.02	<0.02	--	<0.02	<0.02	0.07	0.04	0.12	0.19
Chloride	5.5	17	6.0	8.5	11	5.0	12.0	8.1	6.1	6.1
Fluoride	0.16	0.82	0.83	2.6	1.50	1.0	0.12	0.39	0.60	0.35
Strontium	< 0.05	< 0.05	0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.18	0.08
Dissolved Solids	67	231	130	58	167	150	74	167	156	78
Total Solids	83	232	154	205	178	160	128	242	227	132
Hardness (Total)	10	87	67	19	90	106	33	131	76	73
Alkalinity ($CaCO_3$)	18	105	98	2.0	114	143	16	170	118	96
Conductivity (µmhos/cm @ 25°C)	71	359	191	160	251	269	114	296	170	110
TRACE METALS, mg/l										
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	0.003	<0.002	<0.002	0.015	0.003	0.003	0.006	0.005	0.005	0.004
Manganese	0.032	0.014	0.031	0.042	0.040	0.043	0.028	0.004	0.02	0.012
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.013	0.013	0.034	0.063	0.014	0.013	0.020	0.012	0.012	0.009
RADIO-CHEMICAL DATA, pCi/l										
Gross Alpha Radiation	--	<3.0	<2.4	4.7	2.0	<2.2	11.0	5.7	2.7	<2.3

All sample sets are "Z."
Locations shown in Figures 3.2-7 and 3.2-8

TABLE 3.2-9
(continued)

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELLS

	Observation Well Set 4				Observation Well Set 5				Observation Well Set 6			
Well Number	4-A	4-B	4-C	4-D	5-A	5-B	5-C	5-D	6-A	6-B	6-C	6-D
Depth of Collection Zone	1-18'	20-42'	82-98'	105-129'	1-14'	17-40'	60-80'	95-119'	1-11'	17-45'	71-82'	95-125'
Date Sampled	4/13/78	4/13/78	4/13/78	4/13/78	4/14/78	4/14/78	4/17/78	4/17/78	4/17/78	4/17/78	4/17/78	4/17/78
Water Level Elevation	121.7	121.5	69.9	61.6	120.6	120.1	107.8	86.8	123.9	124.0	65.2	54.7
Sample Number	9288	9290	9292	9294	9296	9298	9300	9302	9342	9344	9346	9348
Temperature °C	17	--	--	--	19	19.5	20.5	21	20.5	21	--	--
Color (APHA Units)	1	1	0	1	25	1	2	1	400	55	0	0
pH (Field)	6.3	--	--	--	--	--	--	--	--	--	--	--
(Lab)	6.4	7.3	7.6	11.0	6.0	5.4	7.5	8.7	3.8	3.6	7.6	8.2
NUTRIENTS, mg/l												
Nitrogen-N												
Ammonium	<0.02	<0.02	<0.02	0.59	2.9	7.6	<0.02	0.03	103	222	0.04	0.16
Nitrate	0.350	0.007	<0.005	<0.005	0.007	8.3	0.075	0.005	<0.005	<0.005	0.016	<0.005
Organic Dissolved	0.18	0.04	<0.02	0.10	0.33	0.18	0.04	0.02	7.4	1.77	0.06	0.02
Phosphates-P												
Ortho	0.660	2.62	0.300	0.060	0.280	0.533	3.66	0.106	460	2100	1.50	0.527
Total Phosphorus	1.40	2.65	0.30	0.07	1.45	0.72	4.50	0.15	528	2520	1.90	0.63
Dissolved Organic Carbon	4.5	6.5	4.0	6.5	14.5	5.0	5.5	1.5	28.0	49.0	2.0	3.5
MAJOR CONSTITUENTS, mg/l												
Iron	0.39	0.25	1.2	0.38	5.5	0.27	3.6	0.80	8.0	170	1.5	0.30
Calcium	12.0	17.8	21.8	6.7	7.8	33.8	30.4	17.1	75.7	994	20.9	21.3
Magnesium	1.9	11.1	17.4	0.90	4.5	20.5	25.4	11.8	74.1	194	20.2	12.2
Sodium	5.5	3.7	3.7	21.5	30.0	32.2	20.2	4.7	518	966	5.3	5.3
Potassium	1.43	0.60	0.72	25.5	1.55	4.3	3.82	0.60	27.3	65.5	0.96	1.08
Sulfate	16	4.4	3.3	11	87	275	117	30	1550	2900	2.4	5.4
Sulfides	0.32	0.46	0.43	0.42	0.27	0.81	0.42	0.43	292	3.4	<0.02	<0.02
Chloride	4.2	4.5	4.5	8.0	18	9.0	9.5	6.0	50	43	5.5	6.5
Fluoride	0.26	0.64	0.36	0.39	0.80	0.58	0.72	0.52	135	0.25	0.74	0.72
Strontium	0.06	0.06	<0.05	0.54	<0.05	<0.05	<0.05	<0.05	0.12	0.09	<0.05	<0.05
Dissolved Solids	26	134	180	217	258	484	362	217	4330	12500	234	170
Total Solids	60	138	210	302	414	502	894	252	4640	12900	246	172
Hardness (Total)	38	90	126	20	38	169	181	91	495	3280	135	104
Alkalinity ($CaCO_3$)	26	113	166	105	40	8.0	169	85	0	0	197	134
Conductivity (µmhos/cm @ 25°C)	99	212	284	400	314	702	524	221	3340	7350	364	263
TRACE METALS, mg/l												
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.21	0.02	<0.02	<0.02
Chromium	0.004	<0.002	0.005	<0.002	0.005	0.004	0.039	0.004	0.012	0.032	0.003	<0.002
Manganese	0.021	0.023	0.036	0.019	0.138	0.268	0.063	0.023	1.82	7.76	0.036	0.016
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.016	0.005	0.011	0.017	0.009	0.022	0.026	0.033	0.022	0.048	0.036	0.012
RADIO-CHEMICAL DATA, pCi/l												
Gross Alpha Radiation	8.4	<1.6	5.1	2.7	7.1	12.0	10.0	<2.3	--	--	<2.9	<2.6

All sample sets are "Z."
Locations are shown in Figures 3.2-7 and 3.2-8

TABLE 3.2-10

GROUNDWATER QUALITY DATA
SUWANNEE RIVER AND SWIFT CREEK PLANTS
OCCIDENTAL SHALLOW POTABLE WELLS

	Suwannee River Chemical Plant		Suwannee River Beneficiation Plant				Swift Creek Beneficiation Plant	
Well Number	CD-1	CD-2	MST	MAB	MD-1	MD-2	SCD-1	SCD-2
Depth of Collection Zone	? -315'	200-248'	160-240'	107-160'	? -115'	? -190'	168-270'	63-75'
Date Sampled	4/16/78	4/18/78	4/18/78	4/18/78	4/18/78	4/18/78	4/13/78	4/19/78
Sample Number	9374	9375	9364	9363	9372	9371	9277	9378
Temperature °C	--	--	--	21	24	--	21	19.5
Color (APHA Units)	1	0	0	0	1	1	1	0
pH (Field)	--	--	--	--	--	--	7.1	--
(Lab)	7.5	7.3	7.7	7.1	7.1	6.8	7.8	6.8
NUTRIENTS, mg/l								
Nitrogen-N								
Ammonium	0.13	0.15	<0.02	<0.02	0.11	0.09	0.05	<0.02
Nitrate	0.013	0.010	0.005	0.012	0.025	0.085	0.010	0.007
Organic Dissolved	<0.02	0.22	<0.02	0.02	0.09	0.05	0.23	0.31
Phosphates-P								
Ortho	0.116	0.148	0.267	0.186	6.00	6.00	0.053	0.356
Total Phosphorus	0.29	0.29	0.30	0.38	12.8	14.4	0.15	0.46
Dissolved Organic Carbon	6.0	4.5	2.5	7.0	5.5	7.0	3.0	71.0
MAJOR CONSTITUENTS, mg/l								
Iron	0.06	0.24	0.48	0.24	0.65	0.81	0.09	2.8
Calcium	29.3	25.1	21.7	91.8	31.2	29.3	65.3	54.7
Magnesium	20.8	21.6	15.5	9.9	21.6	19.3	25.9	24.4
Sodium	12.4	9.2	6.9	5.9	12.4	12.0	11.3	3.8
Potassium	0.96	0.60	0.48	0.60	0.84	0.72	0.96	0.60
Sulfate	45	23	<1.0	<1.0	35	34	9.8	<1.0
Sulfides	0.39	0.14	0.09	0.04	<0.02	0.10	0.14	0.29
Chloride	11	9.0	5.0	6.0	10	11	8.6	4.5
Fluoride	0.37	0.51	0.73	0.33	0.60	1.7	0.33	0.42
Strontium	0.08	<0.05	0.06	0.06	<0.05	<0.05	0.07	0.06
Dissolved Solids	312	271	192	242	248	274	380	258
Total Solids	508	276	196	243	257	278	382	268
Hardness (Total)	159	152	118	270	167	153	270	237
Alkalinity ($CaCO_3$)	178	200	172	230	205	175	277	252
Conductivity (μmhos/cm @ 25°C)	417	402	294	381	435	392	467	435
TRACE METALS, mg/l								
Arsenic	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
Chromium	0.003	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	0.003
Manganese	0.016	0.036	0.029	0.012	0.036	0.035	0.031	0.104
Mercury	< 0.0002	<0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Zinc	0.009	0.005	0.154	0.048	0.009	0.18	0.022	4.3
RADIO-CHEMICAL DATA, pCi/l								
Gross Alpha Radiation	3.2	<2.3	<1.6	9.2	3.9	18.0	<3.1	<1.7

All values are from latest sampling date
Locations shown in Figures 3.2-7 and 2.6-22

TABLE 3.2-11

GROUNDWATER QUALITY DATA
SUWANNEE RIVER AND SWIFT CREEK PLANTS
DEEP PRODUCTION WELLS

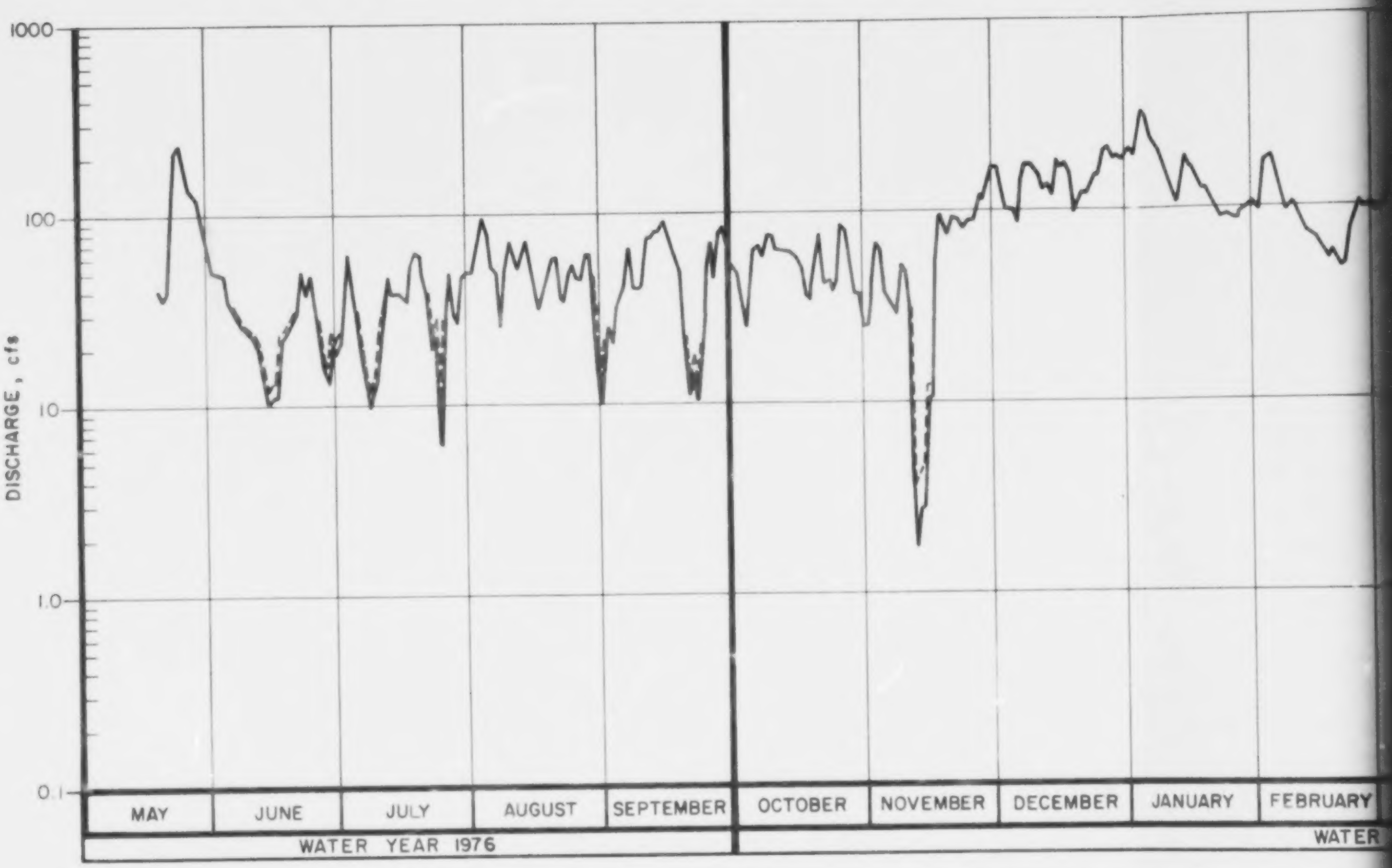
Well Number	Suwannee River Chemical Plant			Suwannee River Beneficiation Plant			Swift Creek Beneficiation Plant	
	C-1	C-2	C-3	M-1	M-2	M-3	SC-1	SC-2
Depth of Collection Zone	189-803'	202-700'	210-800'	180-1265'	204-700'	190-804'	180-800'	186-800'
Date Sampled	4/18/78	3/1/76	4/18/78	4/19/78	4/18/78	4/18/78	4/19/78	4/12/78
Sample Number	9376	--	9361	9380	9373	9362	9377	9278
Temperature °C	--	--	21	--	22	20.5	20.5	21
Color (APHA Units)	12	15	1	55	65	110	2	10
pH (Field)	--	--	--	--	--	--	--	7.2
(Lab)	7.0	7.6	6.9	6.9	7.1	6.9	7.1	7.9
NUTRIENTS, mg/l								
Nitrogen-N								
Ammonium	0.03	--	0.21	0.14	0.22	0.10	0.09	0.02
Nitrate	<0.005	0.21	0.007	0.010	0.013	0.005	0.038	0.013
Organic Dissolved	0.39	--	0.10	<0.02	0.09	0.24	0.19	0.22
Phosphates-P								
Ortho	0.236	--	0.184	0.120	0.640	0.180	0.228	0.093
Total Phosphorus	0.34	--	0.47	0.12	1.22	1.00	0.32	0.13
Dissolved Organic Carbon	11.5	--	11.0	9.0	10.5	10.5	10.0	5.0
MAJOR CONSTITUENTS, mg/l								
Iron	0.27	0.94	0.72	0.49	0.09	0.47	1.1	0.38
Calcium	70.2	99	75.6	32.7	31.0	25.9	54.7	54.7
Magnesium	21.6	15	23.5	20.2	16.0	13.6	20.7	18.8
Sodium	14.3	18	16.6	13.8	10.6	11.1	10.1	12.0
Potassium	1.70	2.1	1.20	1.03	0.84	0.72	0.84	1.2
Sulfate	58	145.0	85	58	42	30	28	23
Sulfides	0.56	0.47	1.28	0.43	0.74	1.04	<0.02	0.96
Chloride	12	21	15	14	12	10	11	9.1
Fluoride	0.44	0.42	0.41	0.35	0.36	0.28	0.39	0.38
Strontium	0.12	--	0.15	0.13	--	0.09	0.06	0.08
Dissolved Solids	313	--	411	262	250	164	248	302
Total Solids	318	447	420	274	256	166	260	310
Hardness (Total)	204	312	286	165	143	121	222	214
Alkalinity ($CaCO_3$)	196	186	178	167	144	125	210	192
Conductivity (umhos/cm @ 25°C)	453	--	560	413	354	296	433	368
TRACE METALS, mg/l								
Arsenic	<0.02	--	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	0.006	--	0.005	0.004	<0.002	<0.002	0.009	<0.002
Manganese	0.02	--	0.034	0.041	0.027	0.031	0.041	0.036
Mercury	<0.0002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.011	--	0.007	0.019	0.007	<0.004	0.048	0.010
RADIO-CHEMICAL DATA, pCi/l								
Gross Alpha Radiation	<3.0	--	<3.1	--	7.4	6.3	<1.4	<1.6

All values are from latest sampling date
Locations shown in Figures 3.2-7 and 2.6-22

TABLE 3.2-12

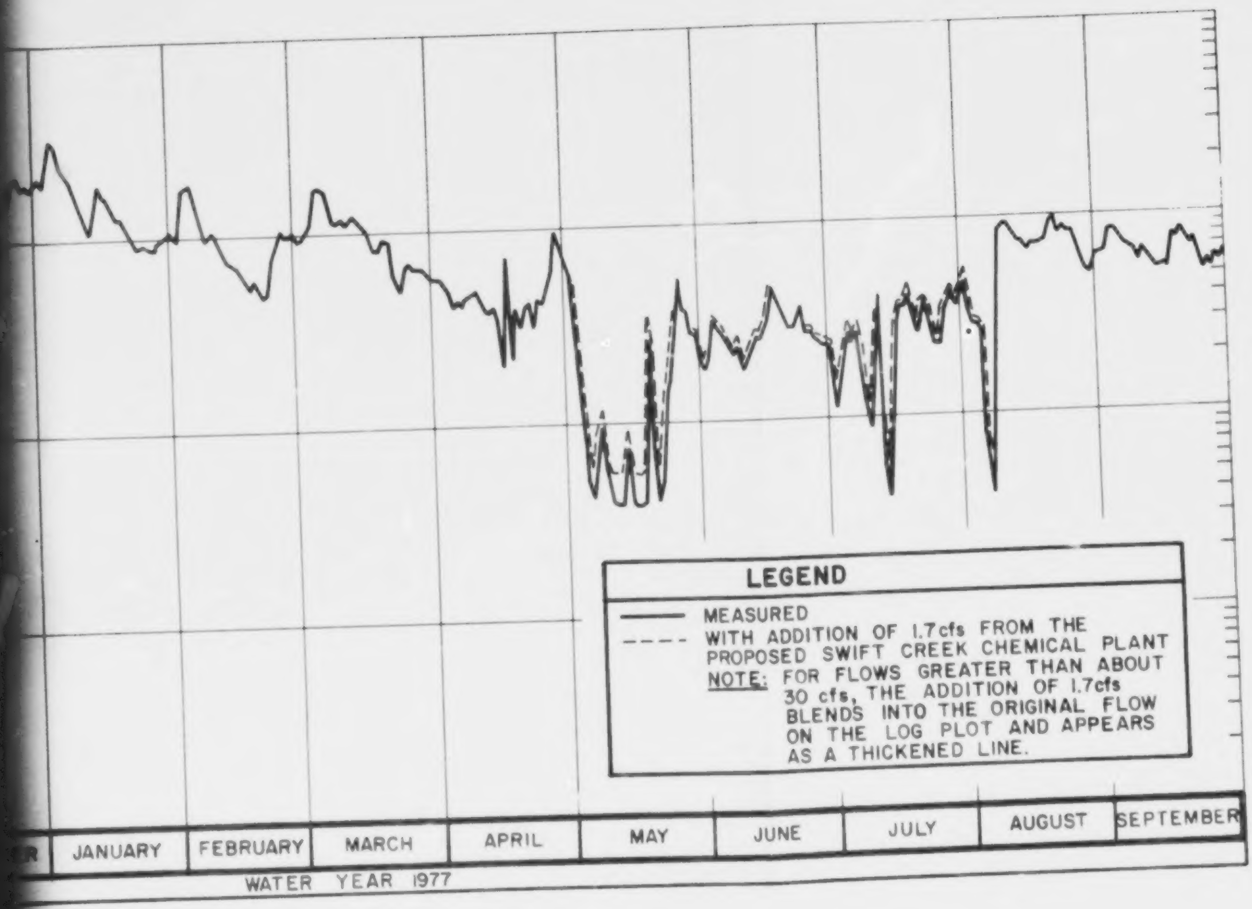
COMPARISON OF WATER QUALITY IN FLORIDAN AQUIFER AT THE EXISTING PLANT WITH REGIONAL DATA

	Swift Creek Occidental Supply Wells (>200 feet deep) and Observation Well 3-E			Suwannee River Occidental Supply Wells (>200 feet deep)			Osceola National Forest and Jasper Well Number 3 (From Table 2.6-28)	
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Maximum
pH	7.1	7.5	7.9	6.9	7.4	8.1	7.0	7.8
Specific Conductance μmhos/cm	368	462	538	294	394	560	361	508
Dissolved Solids, mg/l	246	315	421	164	285	411	232	540
Calcium, mg/l	51	62	72	21	57	179	42	92
Magnesium, mg/l	18	24	30	3	17	36	17	45
Sodium, mg/l	7	12	25	2	11	27	4	19
Potassium, mg/l	0.8	2.4	6.0	0.5	1.1	2.1	0.7	5.5
Sulfate, mg/l	10	29	127	1	47	145	0.5	210
Chloride, mg/l	3	9	15	4	13	28	5.2	18
Fluoride, mg/l	0.32	0.50	1.6	0.28	0.45	0.90	0.2	0.6
Dissolved Organic Carbon, mg/l	3	13	25	2	8	12	0	7
Iron, mg/l	0.06	0.33	1.1	0.06	0.44	2.0	0.02	1.4
Manganese, mg/l	0.02	0.04	0.10	0.01	0.03	0.04	0.01	0.12
Zinc, mg/l	0	0.05	0.11	0	0.04	0.15	0	0.02



DAILY DISCHARGE HYDROGRAPHS FO
AT FACIL, STATION 023

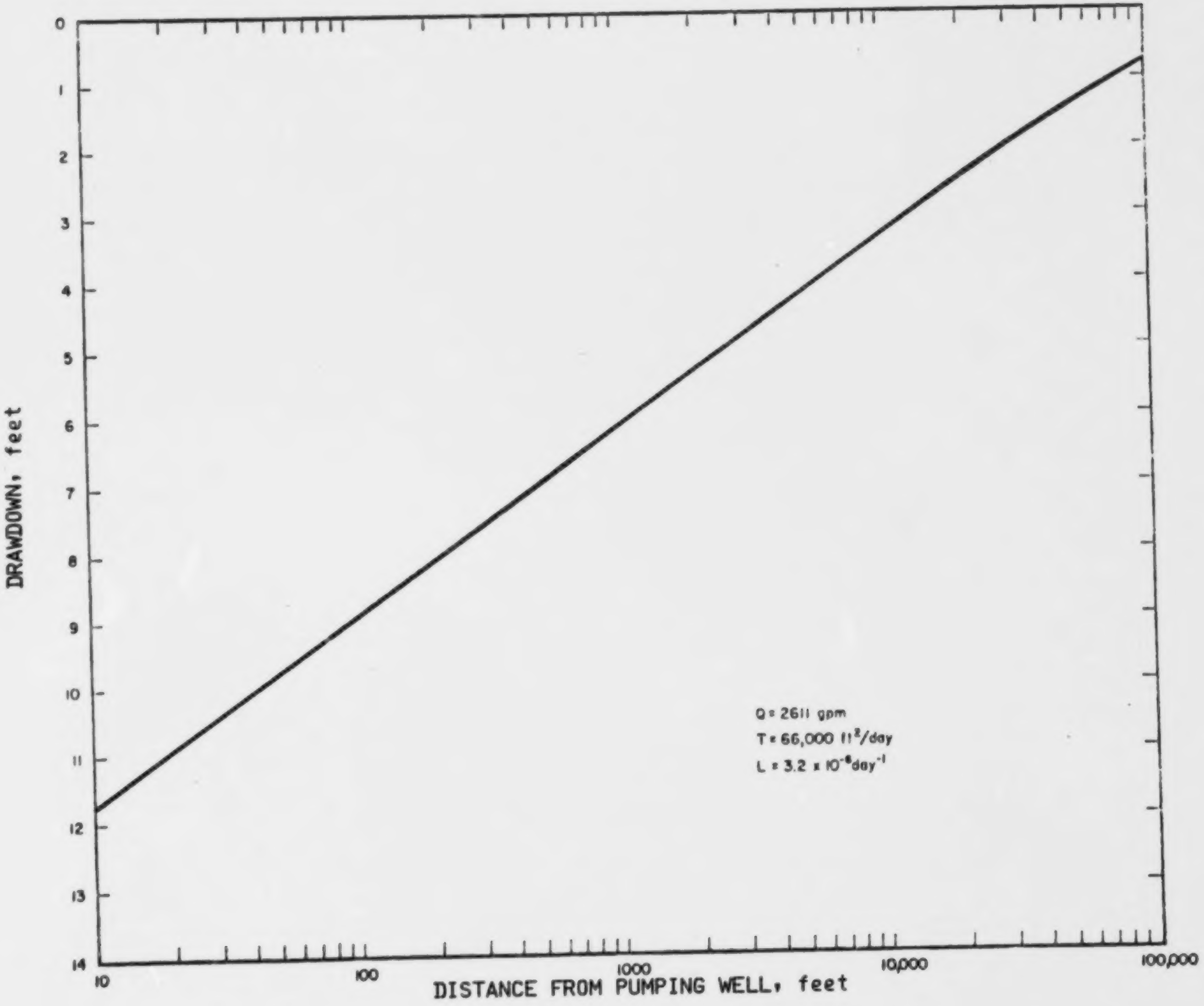
A 1



HYDROGRAPHS FOR SWIFT CREEK
CIL, STATION 02315520

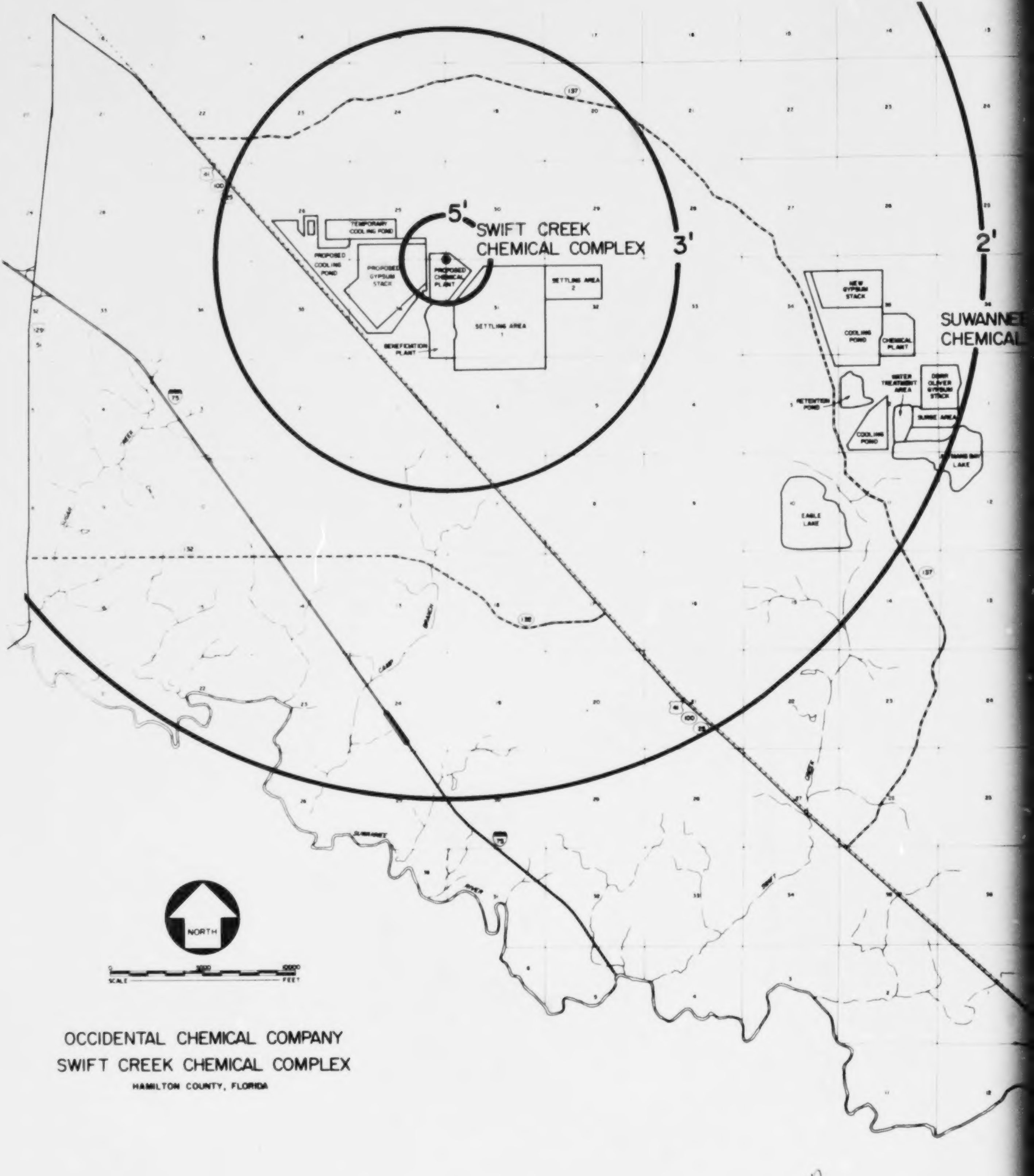
B

FIGURE 3.2-1



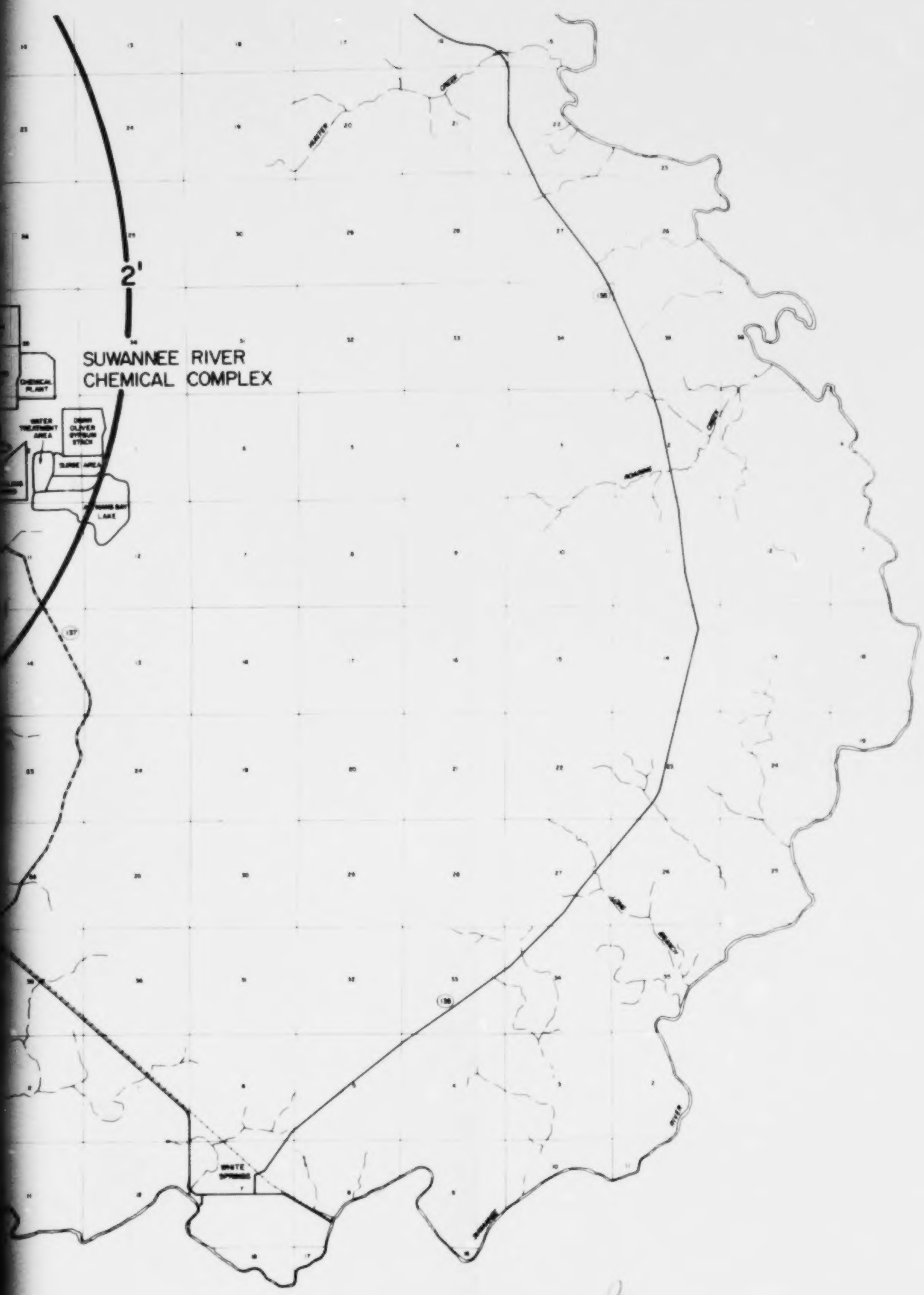
DRAWDOWN OF POTENTIOMETRIC SURFACE AT VARYING DISTANCES FROM THE PROPOSED PUMPING WELL

FIGURE 3.2-2


5'
SWIFT CREEK CHEMICAL COMPLEX
3'
2'
SUWANNEE
CHEMICAL
TEMPORARY COOLING POND
PROPOSED COOLING POND
PROPOSED GYPSUM STACK
PROPOSED CHEMICAL PLANT
SETTLING AREA 2
SETTLING AREA 1
BENEFICIATION PLANT
NEW GYPSUM STACK
COOLING POND
CHEMICAL PLANT
RETENTION POND
WATER TREATMENT AREA
DORR OLIVER GYPSUM STACK
SLIME AREA
COOLING POND
EAGLE LAKE
NORTH
0
5000
10000
SCALE
FEET
OCCIDENTAL CHEMICAL COMPANY
SWIFT CREEK CHEMICAL COMPLEX
HAMILTON COUNTY, FLORIDA

A

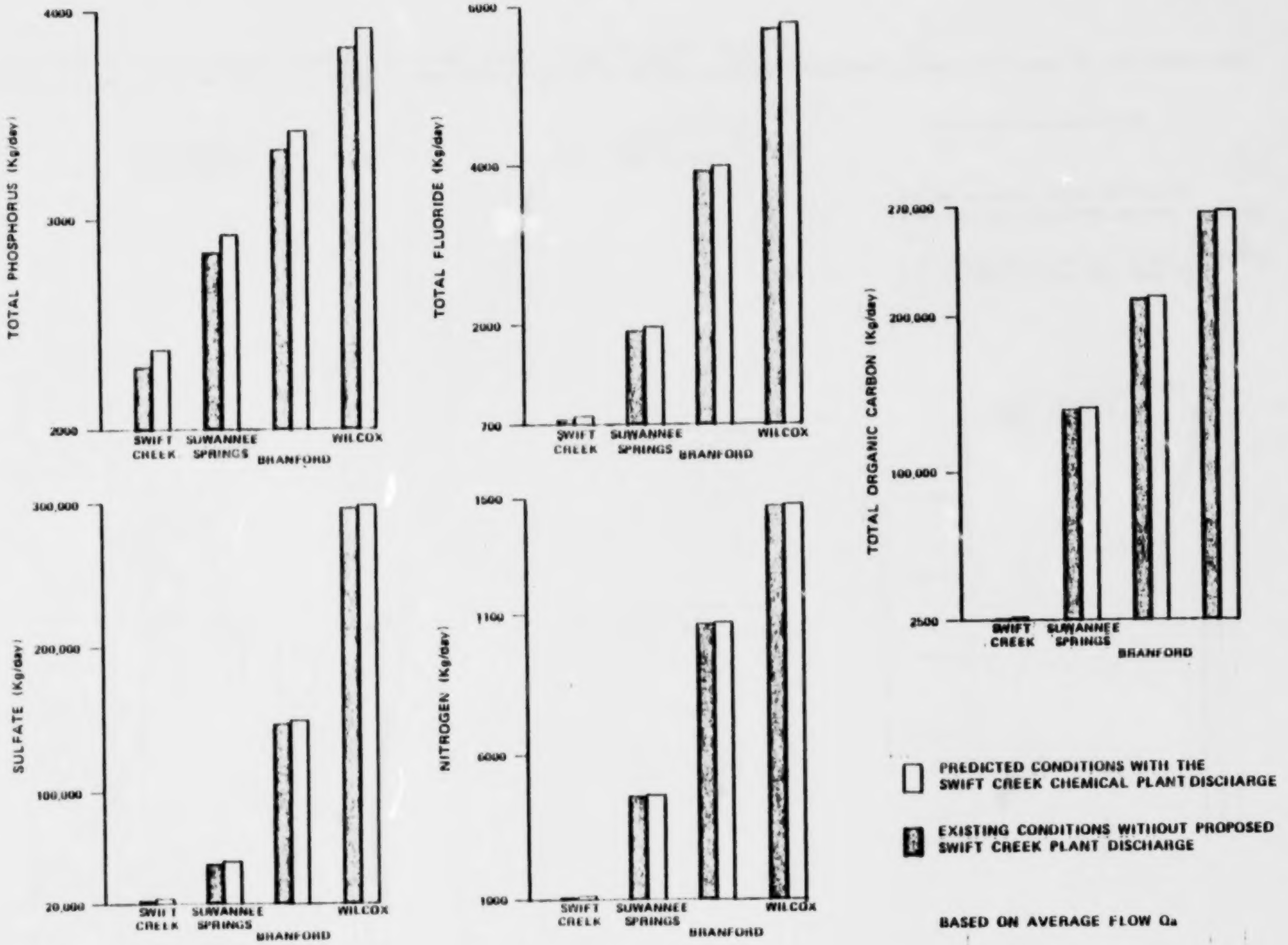
CONTOURS OF DRAWDOWN IN POTENTIOMETR
FLORIDAN AQUIFER AS A RESULT OF


2'
SUWANNEE RIVER
CHEMICAL COMPLEX
CHEMICAL PLANT
WATER TREATMENT AREA
DORR OLIVER GYPSUM STACK
SURGE AREA
WHITE SPRINGS
HUNTER CREEK
ROARING CREEK
SUWANNEE RIVER
136
137

B

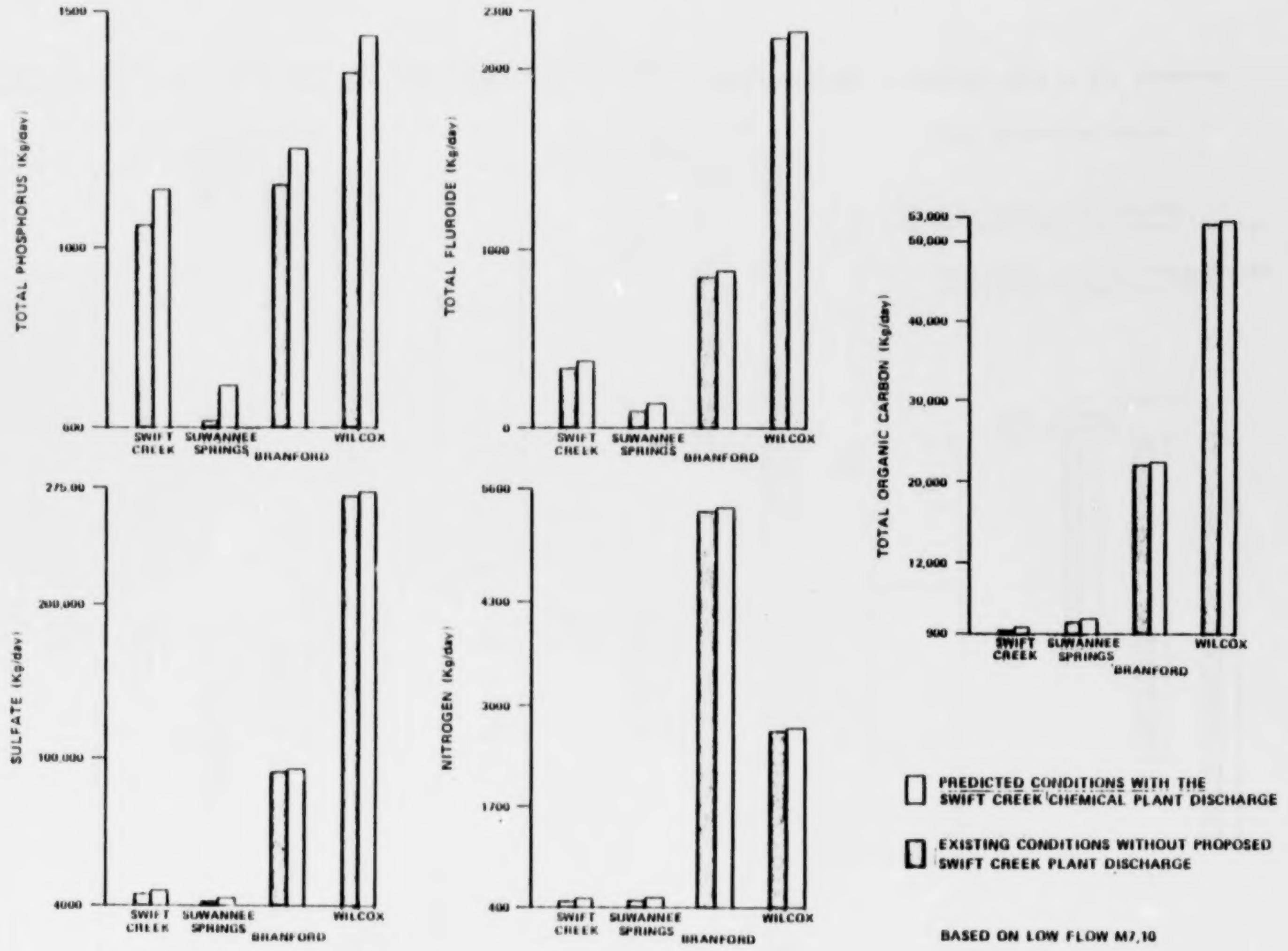
OTENTIOMETRIC SURFACE OF
RESULT OF PUMPING

FIGURE 3.2-3



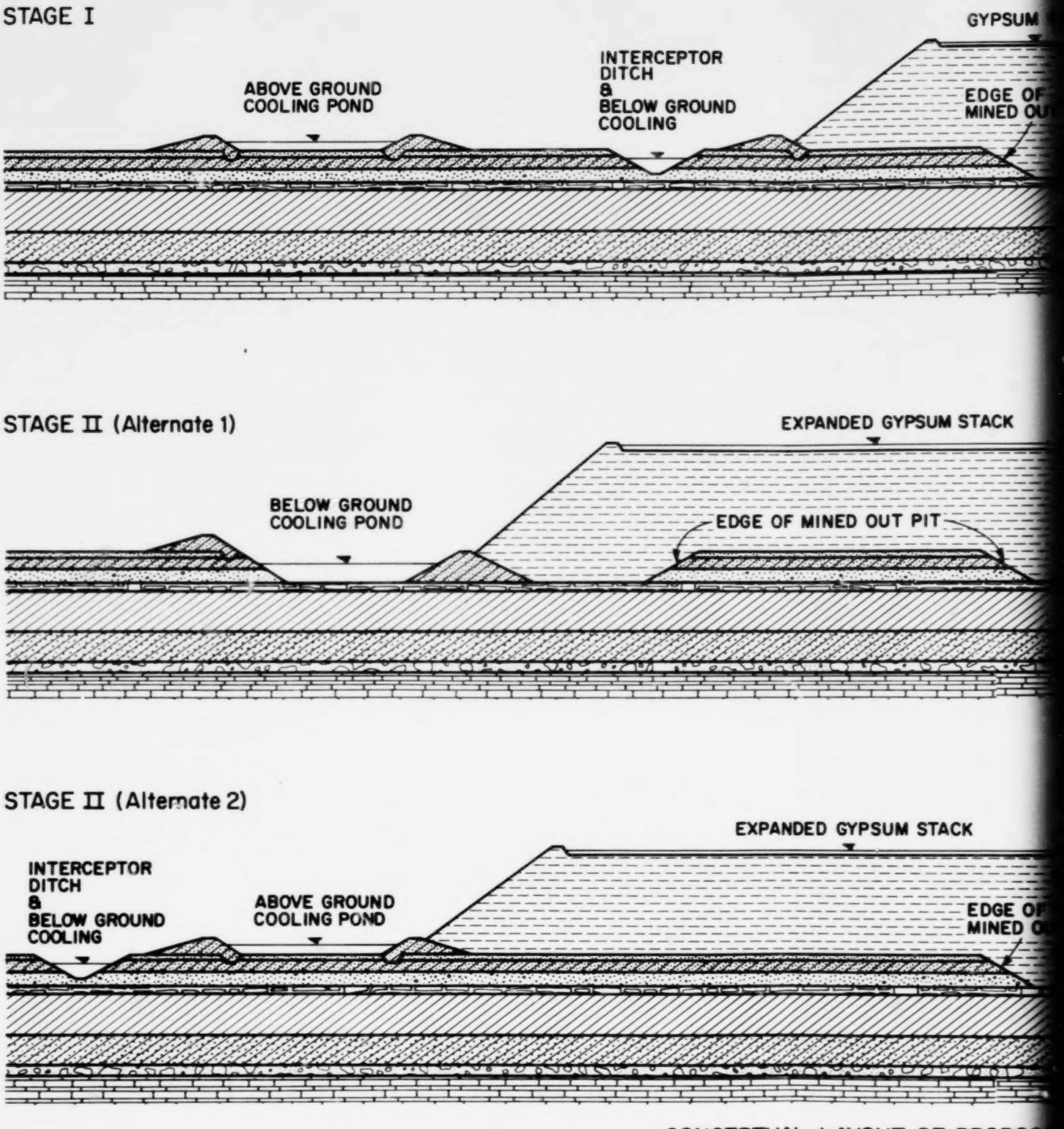
PREDICTED INCREASES IN SELECTED PARAMETERS UNDER AVERAGE FLOW IN SWIFT CREEK AND AT USGS STATIONS ON THE SUWANNEE RIVER DUE TO THE DISCHARGE FROM THE PROPOSED SWIFT CREEK CHEMICAL PLANT

FIGURE 3.2 4



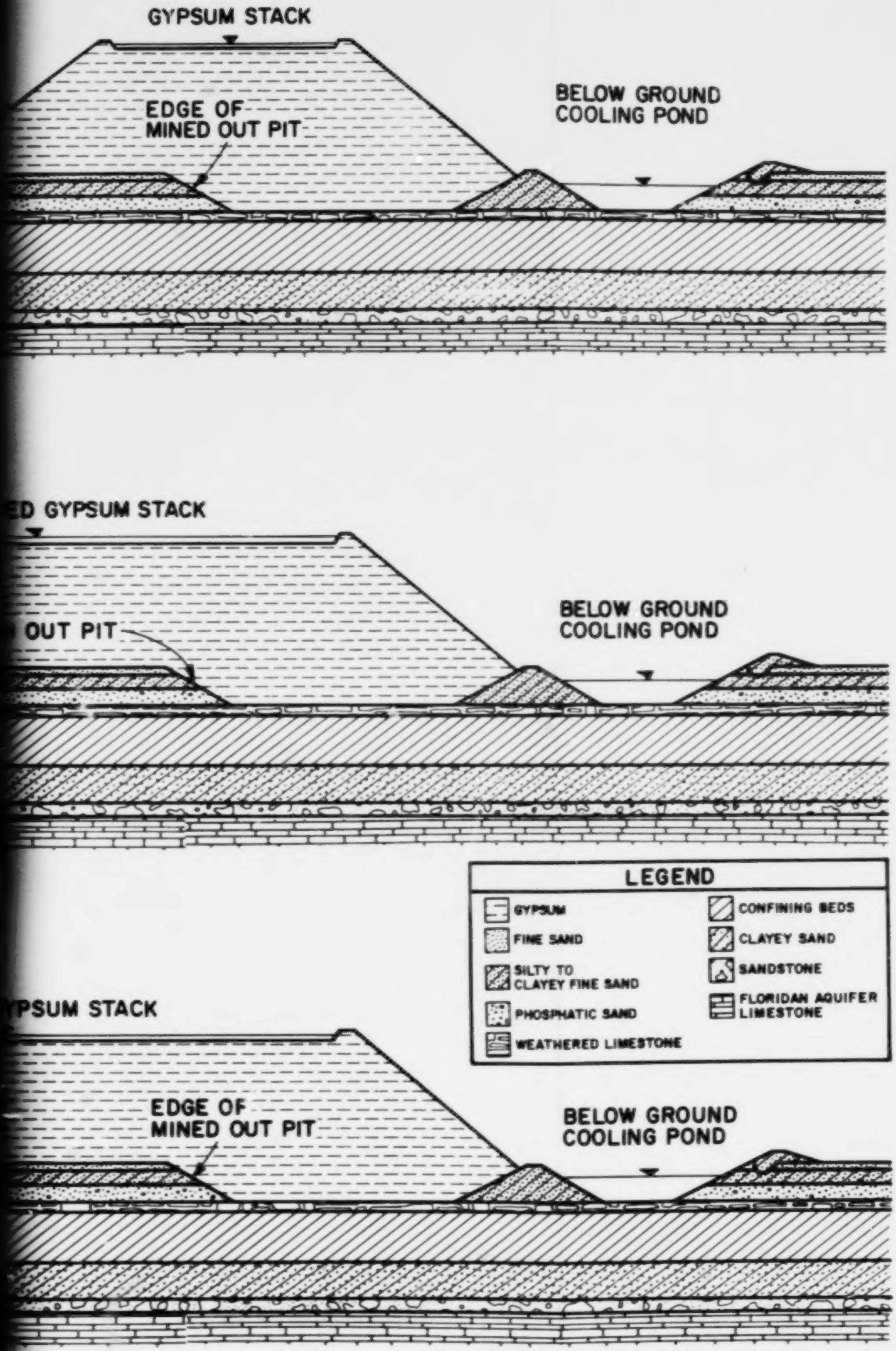
PREDICTED INCREASES IN SELECTED PARAMETERS UNDER LOW FLOW (M7,10) IN SWIFT CREEK AND AT USGS STATIONS ON THE SUWANNEE RIVER DUE TO THE DISCHARGE FROM THE PROPOSED SWIFT CREEK CHEMICAL PLANT

FIGURE 3.2 5


STAGE I
GYPSUM
INTERCEPTOR DITCH & BELOW GROUND COOLING
ABOVE GROUND COOLING POND
EDGE OF
MINED OU
STAGE II (Alternate 1)
EXPANDED GYPSUM STACK
BELOW GROUND COOLING POND
EDGE OF MINED OUT PIT
STAGE II (Alternate 2)
EXPANDED GYPSUM STACK
INTERCEPTOR DITCH & BELOW GROUND COOLING
ABOVE GROUND COOLING POND
EDGE OF
MINED OU

CONCEPTUAL LAYOUT OF PROPOS
GYPSUM STACK AND COOLING PO

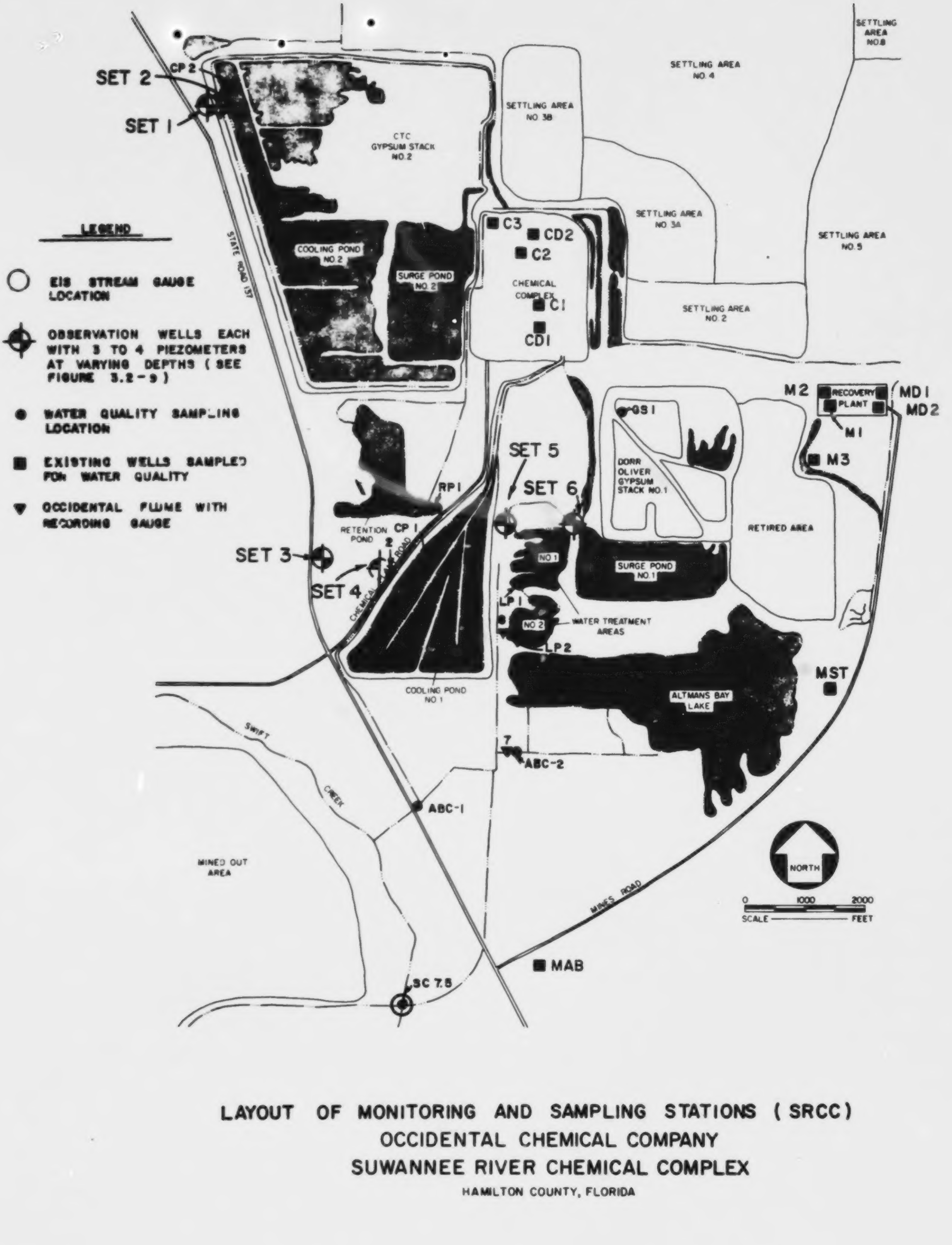
A


GYPSUM STACK
EDGE OF
MINED OUT PIT
BELOW GROUND
COOLING POND
ED GYPSUM STACK
OUT PIT
BELOW GROUND
COOLING POND
LEGEND
GYPSUM
FINE SAND
SILTY TO
CLAYEY FINE SAND
PHOSPHATIC SAND
WEATHERED LIMESTONE
CONFINING BEDS
CLAYEY SAND
SANDSTONE
FLORIDAN AQUIFER
LIMESTONE
YPSUM STACK
EDGE OF
MINED OUT PIT
BELOW GROUND
COOLING POND

YOUT OF PROPOSED
ND COOLING PONDS

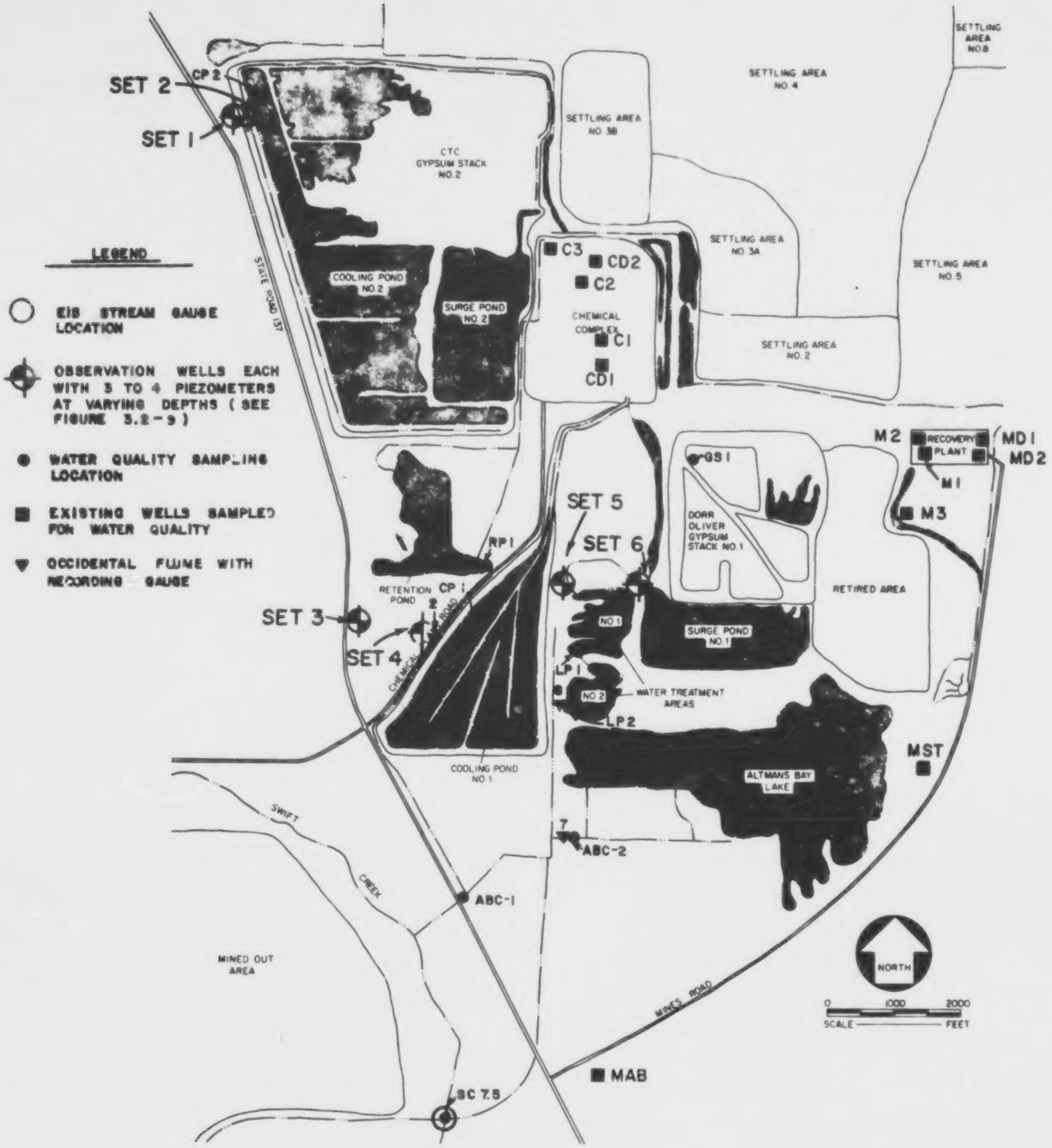
B

FIGURE 3.2-6


SET 2
CP 2
SET 1
CTC GYPSUM STACK NO.2
SETTLING AREA NO 3B
SETTLING AREA NO 4
SETTLING AREA NO 8
LEGEND
EIS STREAM GAUGE LOCATION
OBSERVATION WELLS EACH WITH 3 TO 4 PIEZOMETERS AT VARYING DEPTHS (SEE FIGURE 3.2-9)
WATER QUALITY SAMPLING LOCATION
EXISTING WELLS SAMPLED FOR WATER QUALITY
OCCIDENTAL FLUME WITH RECORDING GAUGE
STATE ROAD 137
COOLING POND NO 2
SURGE POND NO 2
C3
CD2
C2
CHEMICAL COMPLEX
C1
CD1
SETTLING AREA NO 3A
SETTLING AREA NO 5
SETTLING AREA NO 2
M2
RECOVERY PLANT
MD1
MD2
M1
M3
GS1
DORR OLIVER GYPSUM STACK NO.1
SET 5
SET 6
RP1
RETENTION POND
CP 1
2
SET 3
SET 4
CHEMICAL PLANT ROAD
NO 1
SURGE POND NO 1
RETIRED AREA
LP1
8
NO 2
WATER TREATMENT AREAS
LP2
COOLING POND NO 1
ALTMANS BAY LAKE
MST
SWIFT CREEK
7
ABC-2
ABC-1
MINED OUT AREA
NORTH
0
1000
2000
SCALE
FEET
MINES ROAD
MAB
SC 7.5

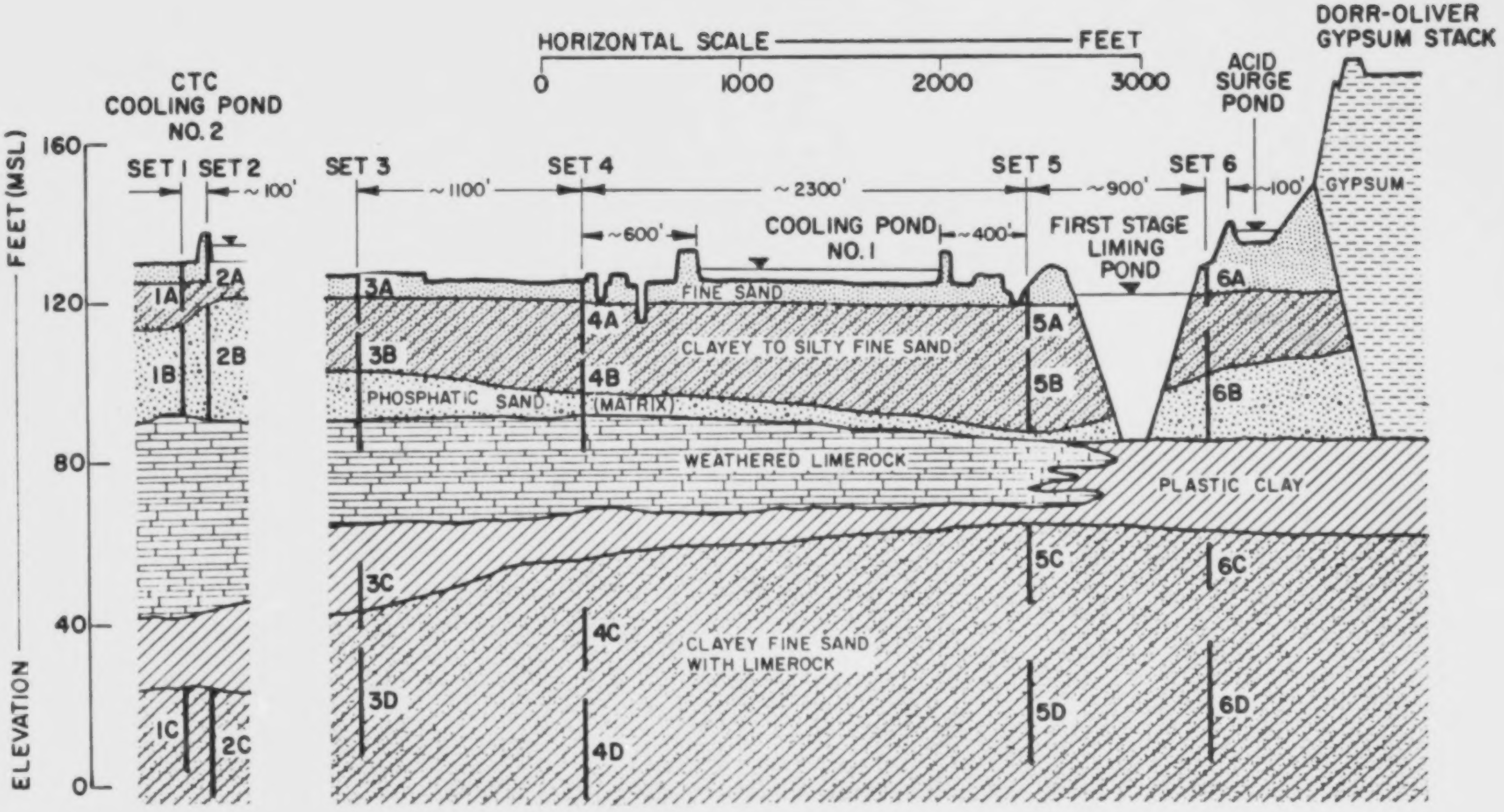
LAYOUT OF MONITORING AND SAMPLING STATIONS (SRCC)
OCCIDENTAL CHEMICAL COMPANY
SUWANNEE RIVER CHEMICAL COMPLEX
HAMILTON COUNTY, FLORIDA

FIGURE 3.2-7


LEGEND
EIS STREAM GAUGE LOCATION
OBSERVATION WELLS EACH WITH 3 TO 4 PIEZOMETERS AT VARYING DEPTHS (SEE FIGURE 3.2-9)
WATER QUALITY SAMPLING LOCATION
EXISTING WELLS SAMPLED FOR WATER QUALITY
OCCIDENTAL FLUME WITH RECORDING GAUGE
SET 2
CP 2
SET 1
CTC GYPSUM STACK NO.2
COOLING POND NO.2
SURGE POND NO.2
STATE ROAD 137
SETTLING AREA NO.3B
SETTLING AREA NO.4
SETTLING AREA NO.8
SETTLING AREA NO.3A
SETTLING AREA NO.5
SETTLING AREA NO.2
C3
CD2
C2
CHEMICAL COMPLEX
C1
CD1
M2
RECOVERY PLANT
MD1
MD2
M1
M3
GS1
DORR OLIVER GYPSUM STACK NO.1
RETIRED AREA
SET 5
SET 6
RP1
RETENTION POND
CP 1
SET 3
2
SET 4
CHEMICAL PLANT ROAD
NO.1
SURGE POND NO.1
LP1
NO.2
WATER TREATMENT AREAS
LP2
COOLING POND NO.1
ALTMANS BAY LAKE
MST
SWIFT CREEK
7
ABC-2
ABC-1
MINED OUT AREA
NORTH
0
1000
2000
SCALE FEET
MINES ROAD
MAB
SC 7.5

LAYOUT OF MONITORING AND SAMPLING STATIONS (SRCC)
OCCIDENTAL CHEMICAL COMPANY
SUWANNEE RIVER CHEMICAL COMPLEX
HAMILTON COUNTY, FLORIDA

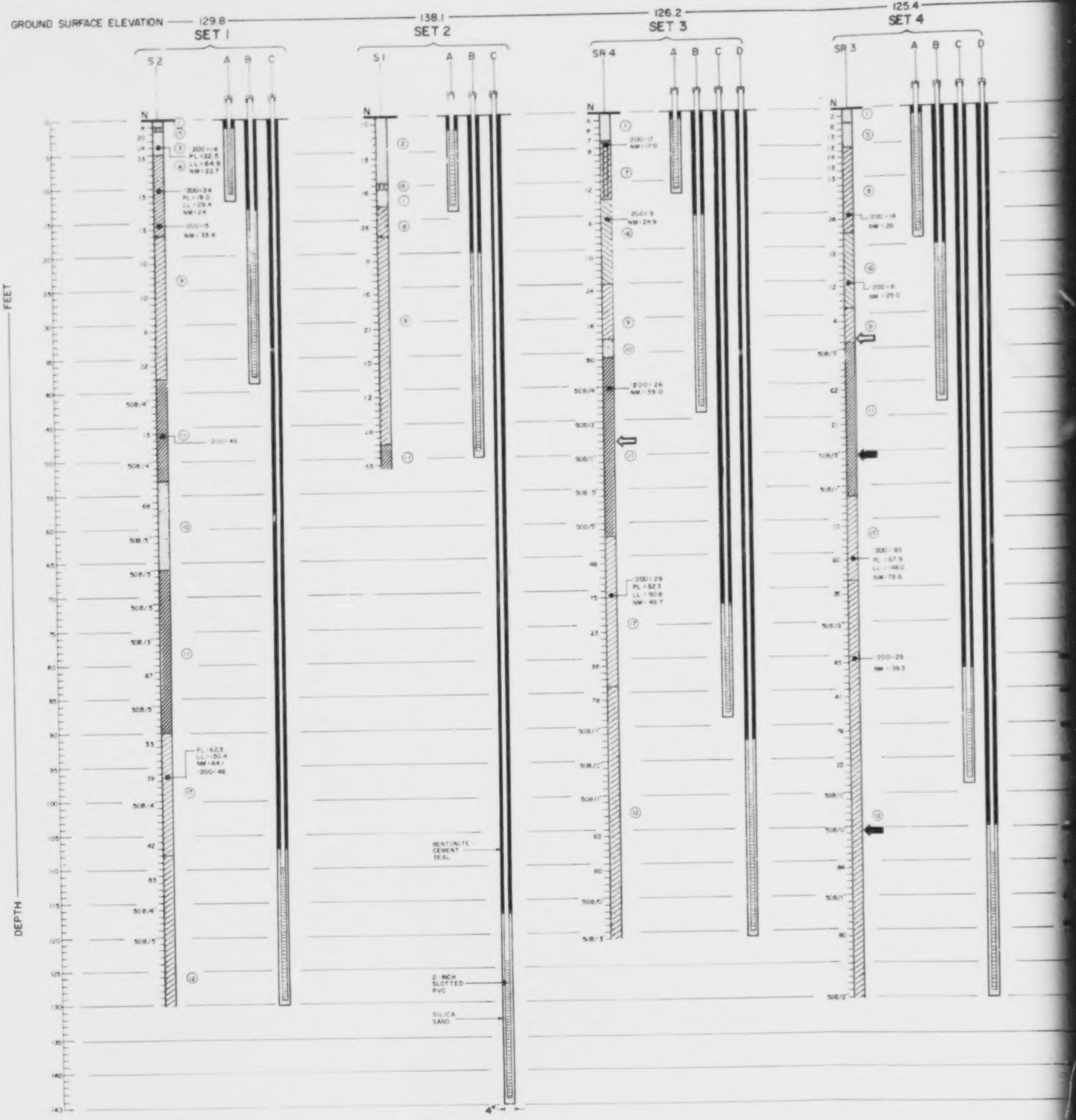
FIGURE 3.2-7



HORIZONTAL SCALE — FEET
0
1000
2000
3000
ELEVATION — FEET (MSL)
160
120
80
40
0
CTC COOLING POND NO. 2
SET 1
SET 2
~100'
SET 3
SET 4
SET 5
SET 6
~1100'
~2300'
~900'
~100'
~600'
~400'
COOLING POND NO. 1
FIRST STAGE LIMING POND
ACID SURGE POND
DORR-OLIVER GYPSUM STACK
GYPSUM
FINE SAND
CLAYEY TO SILTY FINE SAND
PHOSPHATIC SAND (MATRIX)
WEATHERED LIMEROCK
PLASTIC CLAY
CLAYEY FINE SAND WITH LIMEROCK
1A
1B
1C
2A
2B
2C
3A
3B
3C
3D
4A
4B
4C
4D
5A
5B
5C
5D
6A
6B
6C
6D

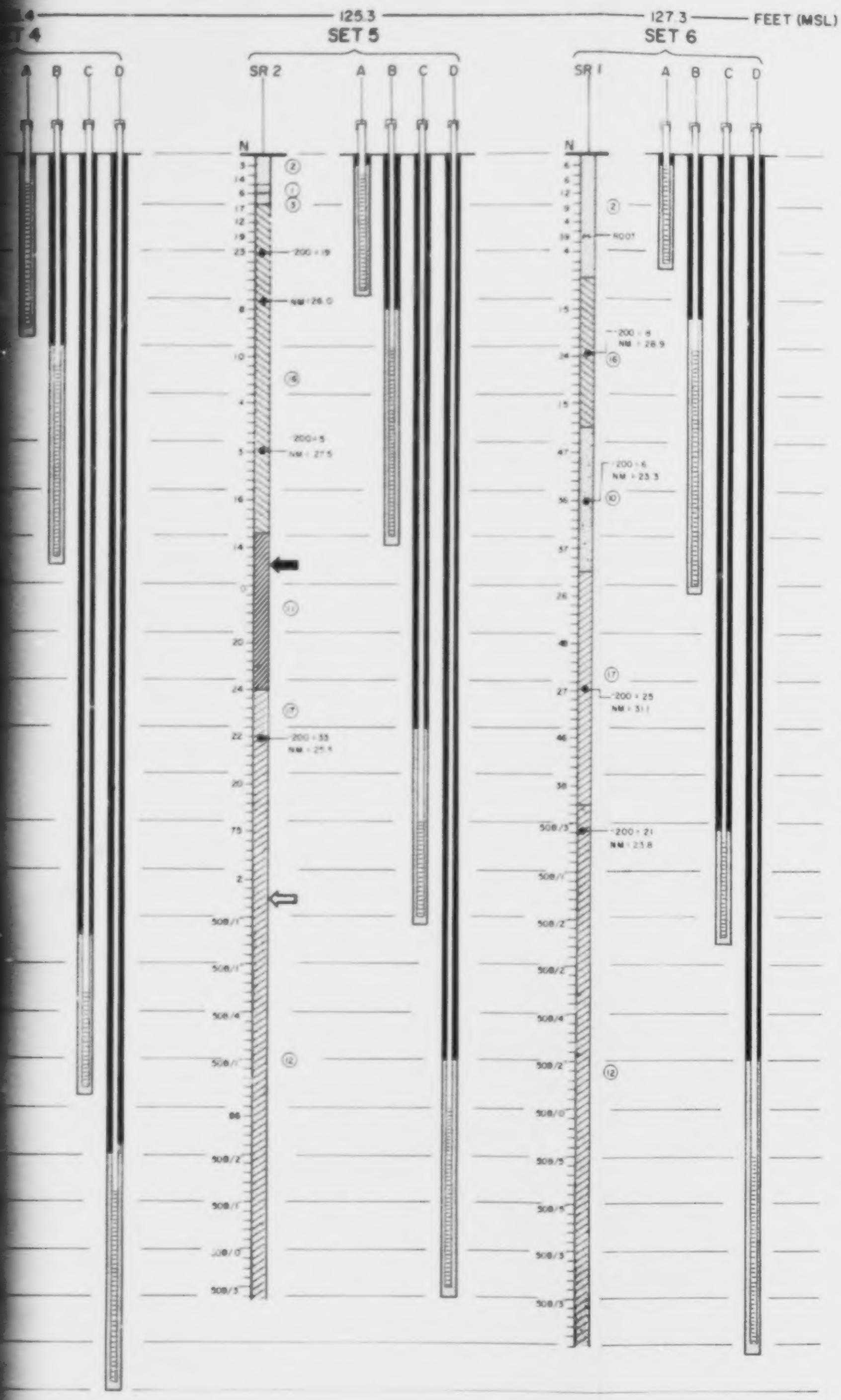
CROSS-SECTION SHOWING LAYOUT OF OBSERVATION WELLS AT THE SUWANNEE RIVER CHEMICAL PLANT

FIGURE 3.2-8

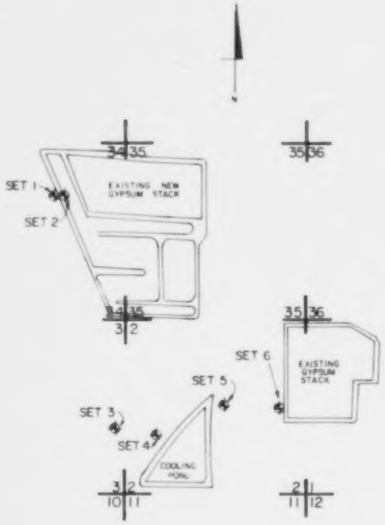

GROUND SURFACE ELEVATION
129.8
SET 1
S2
A
B
C
138.1
SET 2
S1
A
B
C
126.2
SET 3
SR 4
A
B
C
D
125.4
SET 4
SR 3
A
B
C
D
N
FEET
DEPTH
BENTONITE-CEMENT SEAL
2-INCH SLOTTED PVC
SILICA SAND
4"

OBSERVATION WELLS AT EXISTING
SUWANNEE RIVER CHEMICAL COMPLEX

A



4
T 4
125.3
SET 5
127.3
FEET (MSL)
SET 6
A
B
C
D
SR 2
SR 1
N
②
①
③
-200 = 19
NM = 26.0
⑯
-200 = 5
NM = 27.5
⑪
⑰
-200 = 33
NM = 25.1
⑫
ROOT
-200 = 8
NM = 28.9
-200 = 6
NM = 23.3
⑩
-200 = 25
NM = 31.1
-200 = 21
NM = 23.8
50B/3
50B/1
50B/2
50B/4
50B/0



N
34 35
35 36
EXISTING NEW GYPSUM STACK
SET 1
SET 2
3 2
SET 6
EXISTING GYPSUM STACK
SET 5
SET 3
SET 4
COOLING POND
3 2
10 11
2 1
11 12

BORING LOCATION PLAN

LEGEND

☐	①	GRAY TO DARK GRAY FINE SAND w/ROOTS (TOPSOIL)
☐	②	MIXED BROWN AND GRAY FINE SAND (FILL)
☐	③	LIGHT GRAY FINE SAND
▩	④	LIGHT REDDISH BROWN AND DARK BROWN FINE SAND (HARDPAN TYPE)
☐	⑤	VERY LIGHT GRAY FINE SAND
☐	⑥	LIGHT YELLOWISH BROWN FINE SAND
▨	7)	BROWN TO GRAYISH BROWN SILTY TO SLIGHTLY CLAYEY FINE SAND
▨	⑧	LIGHT BROWNISH GRAY CLAYEY FINE SAND MOTTLED ORANGISH BROWN FINE SAND
▨	⑨	GRAYISH BROWN SLIGHTLY CLAYEY TO CLAYEY FINE SAND w/OCCASIONAL PHOSPHATE
☐	10)	GREENISH GRAY SAND w/PHOSPHATE (MATRIX)
▨	⑪	YELLOWISH GRAY CLAY TO CONSOLIDATED CLAY w/ SEAMS OF SAND MIXED w/PHOSPHATES
▨	⑫	LIGHT GREENISH GRAY CLAYEY FINE SAND w/ CALCAREOUS LAYERS
▨	⑬	MIXED BROWN CLAYEY FINE SAND, CLAY AND CONSOLIDATED CLAY
☐	⑭	LIGHT BROWN TO WHITE FINE SAND
▥	⑮	BLACK SILTY ORGANIC SAND
▧	⑯	GRAY SLIGHTLY CLAYEY TO CLAYEY FINE SAND
▨	⑰	DARK GREENISH GRAY SLIGHTLY SANDY CLAY
▤	⑱	WHITE TO CREAM CALCAREOUS CLAY TO SOFT LIMEROCK
	⊕	OBSERVATION WELLS-BORING LOCATIONS
	N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
	-200	PERCENT PASSING NO.200 SIEVE
	NM	NATURAL MOISTURE IN PERCENT
	PL	PLASTIC LIMIT IN PERCENT
	LL	LIQUID LIMIT IN PERCENT
	⇦	PARTIAL LOSS OF DRILLING FLUID CIRCULATION
	⬅	COMPLETE LOSS OF DRILLING FLUID CIRCULATION

NOTE: THE BORING LOGS AND RELATED INFORMATION REPRESENT SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ONLY AND ON THE PARTICULAR DATE DRILLED.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

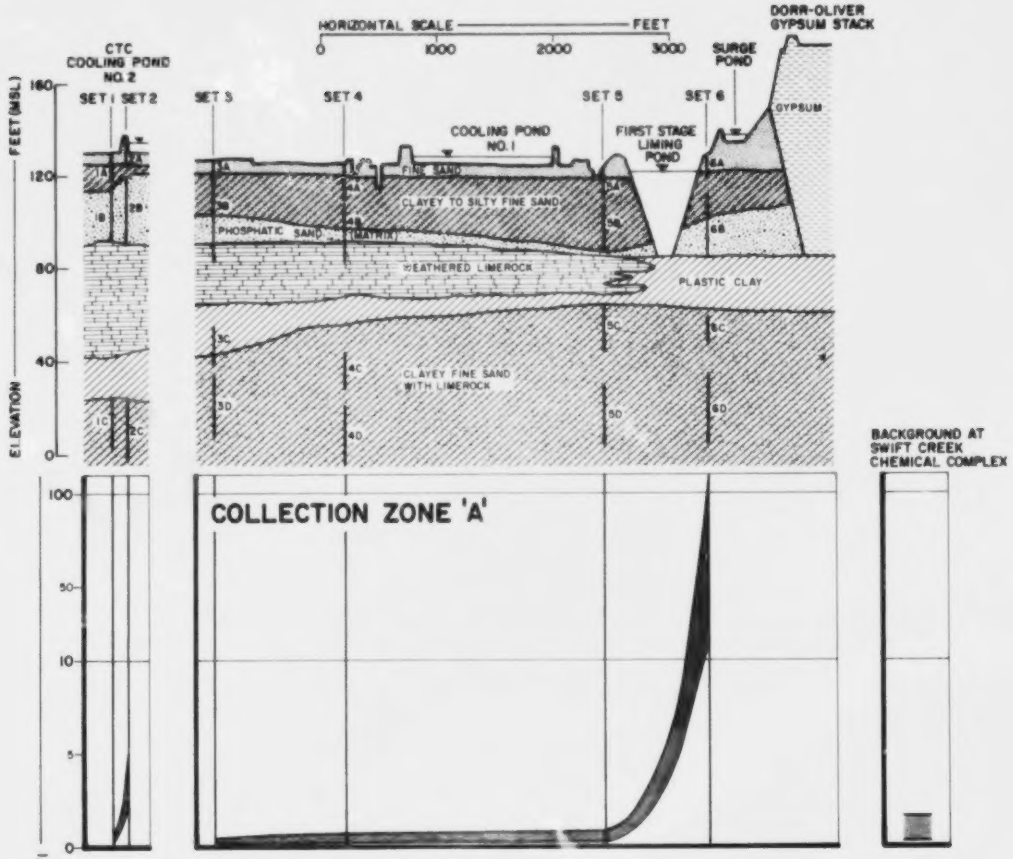
II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT 'N'
VERY SOFT	>1/4	0 TO 2
SOFT	1/4 TO 1/2	2 TO 4
MEDIUM STIFF	1/2 TO 1	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	>4	>30

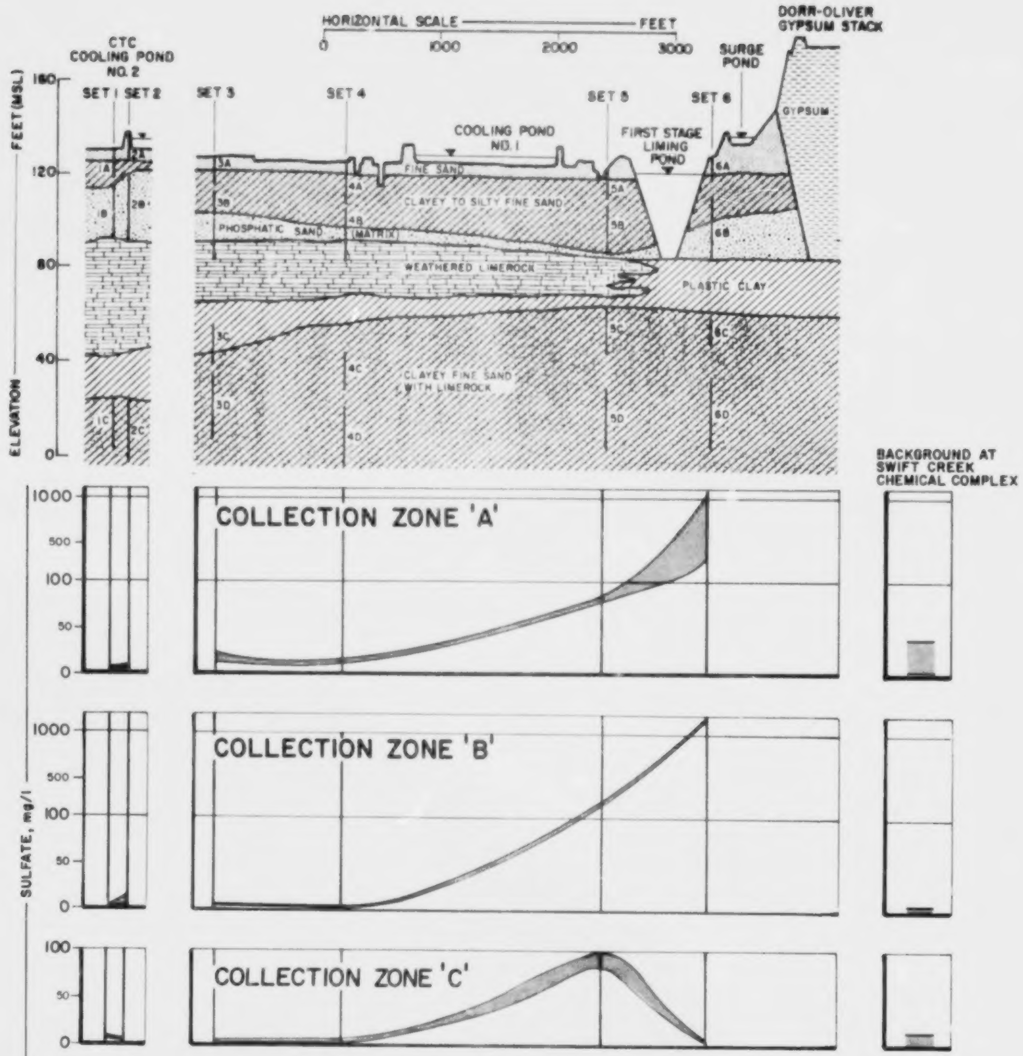
LS AT EXISTING
EMICAL COMPLEX

B

FIGURE 3.2-9

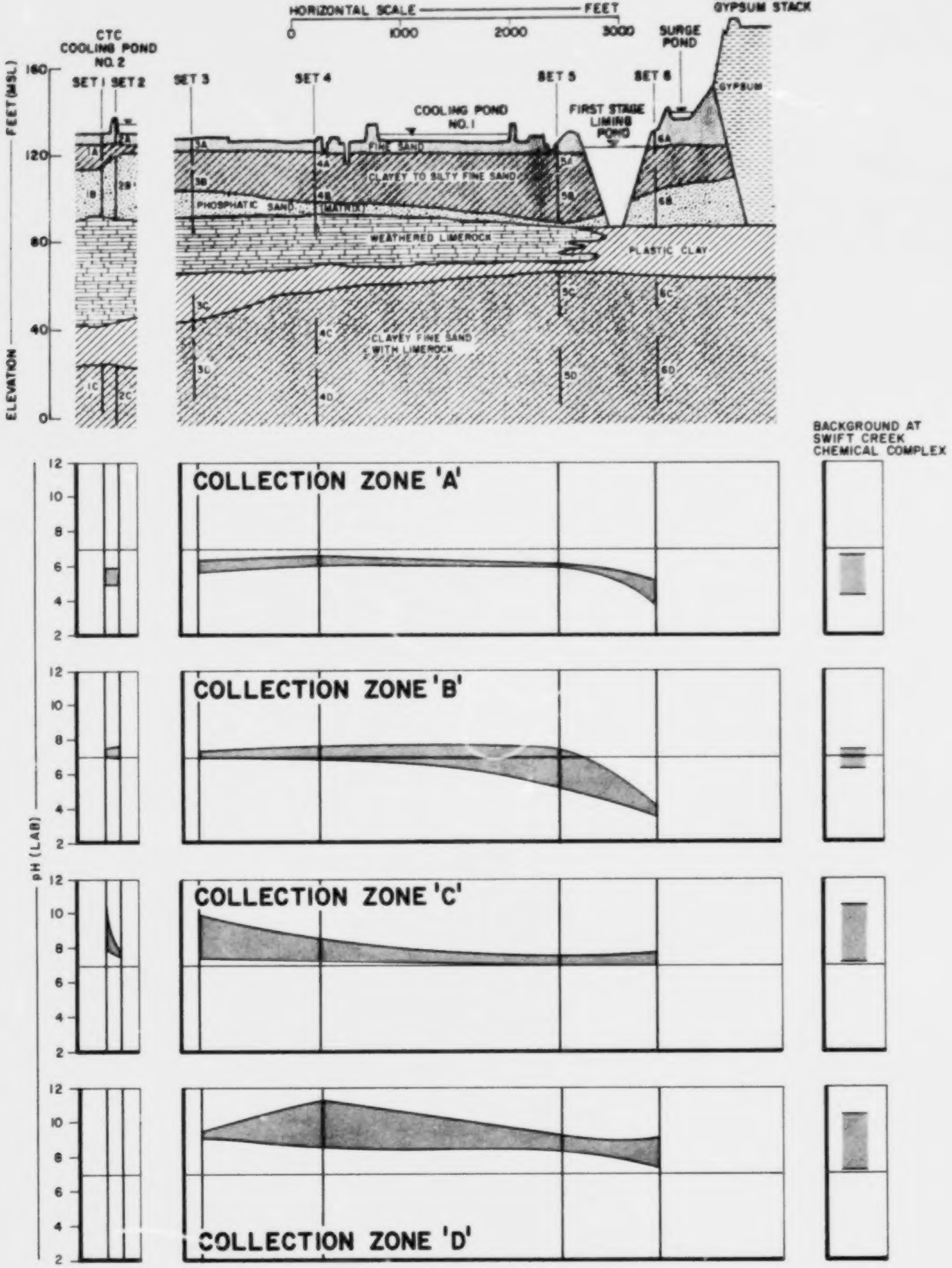


FLUORIDE CONCENTRATION PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND



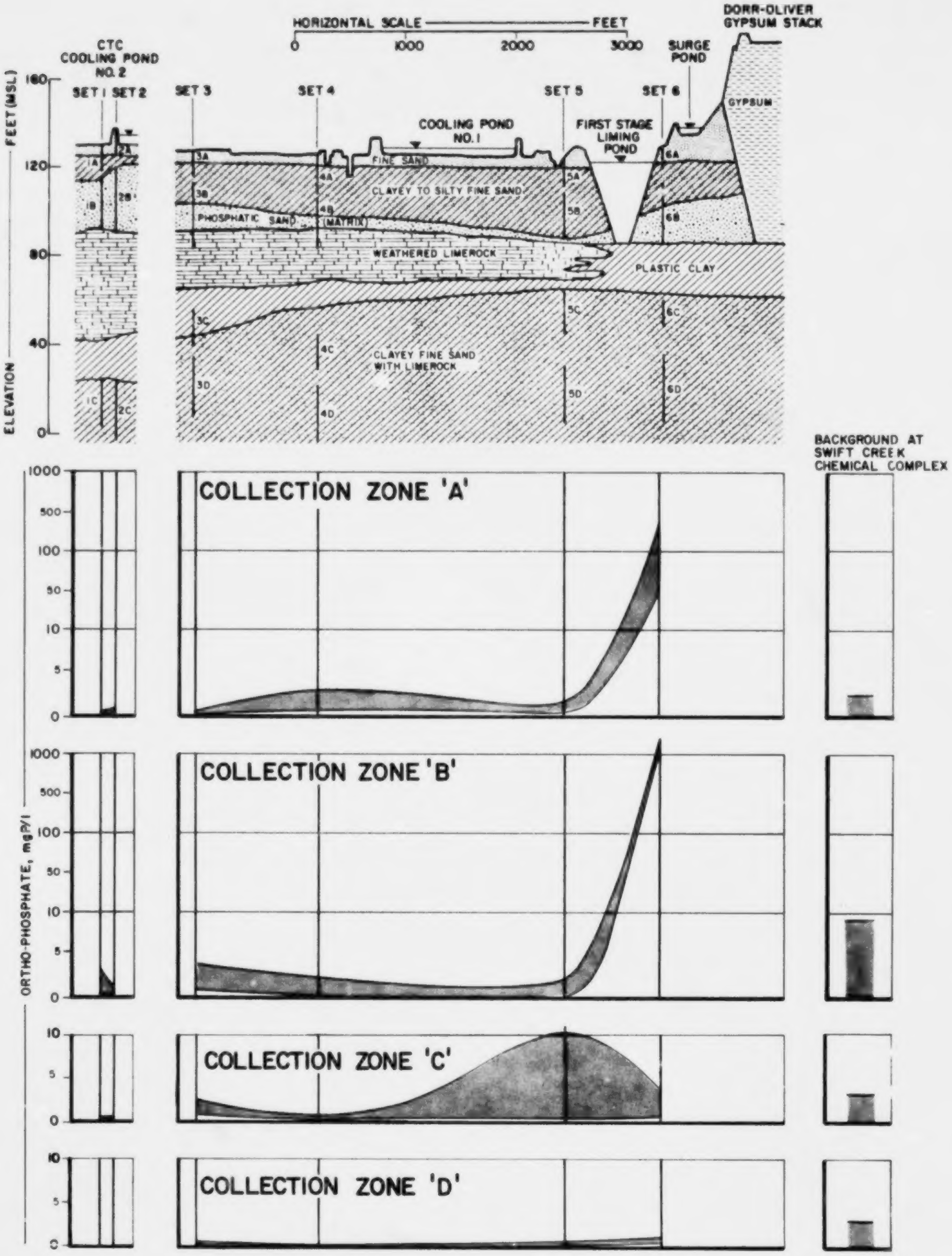
SULFATE CONCENTRATION PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-11



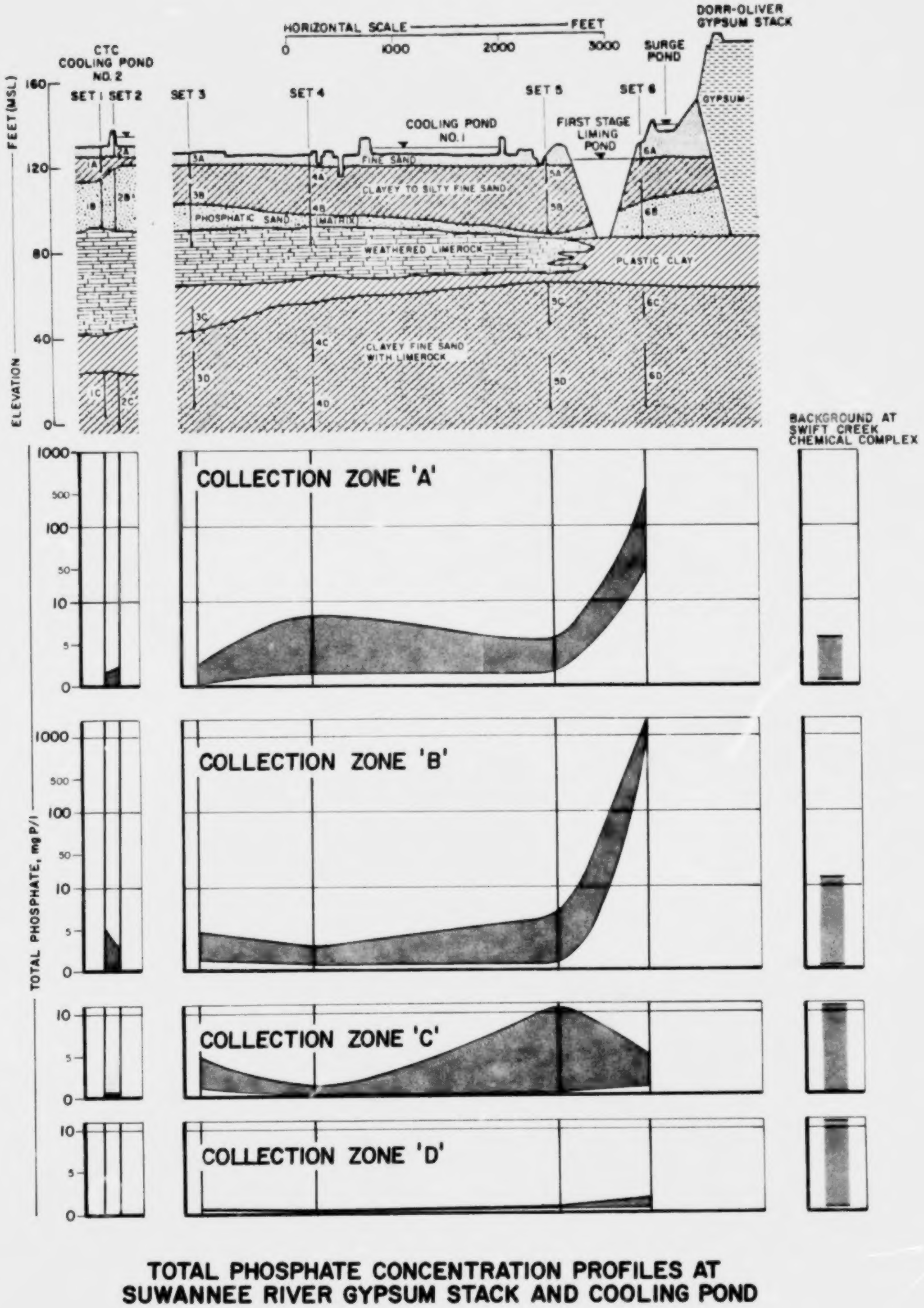
pH PROFILES AT SUWANNEE RIVER
GYPSUM STACK AND COOLING POND

FIGURE 3.2-12



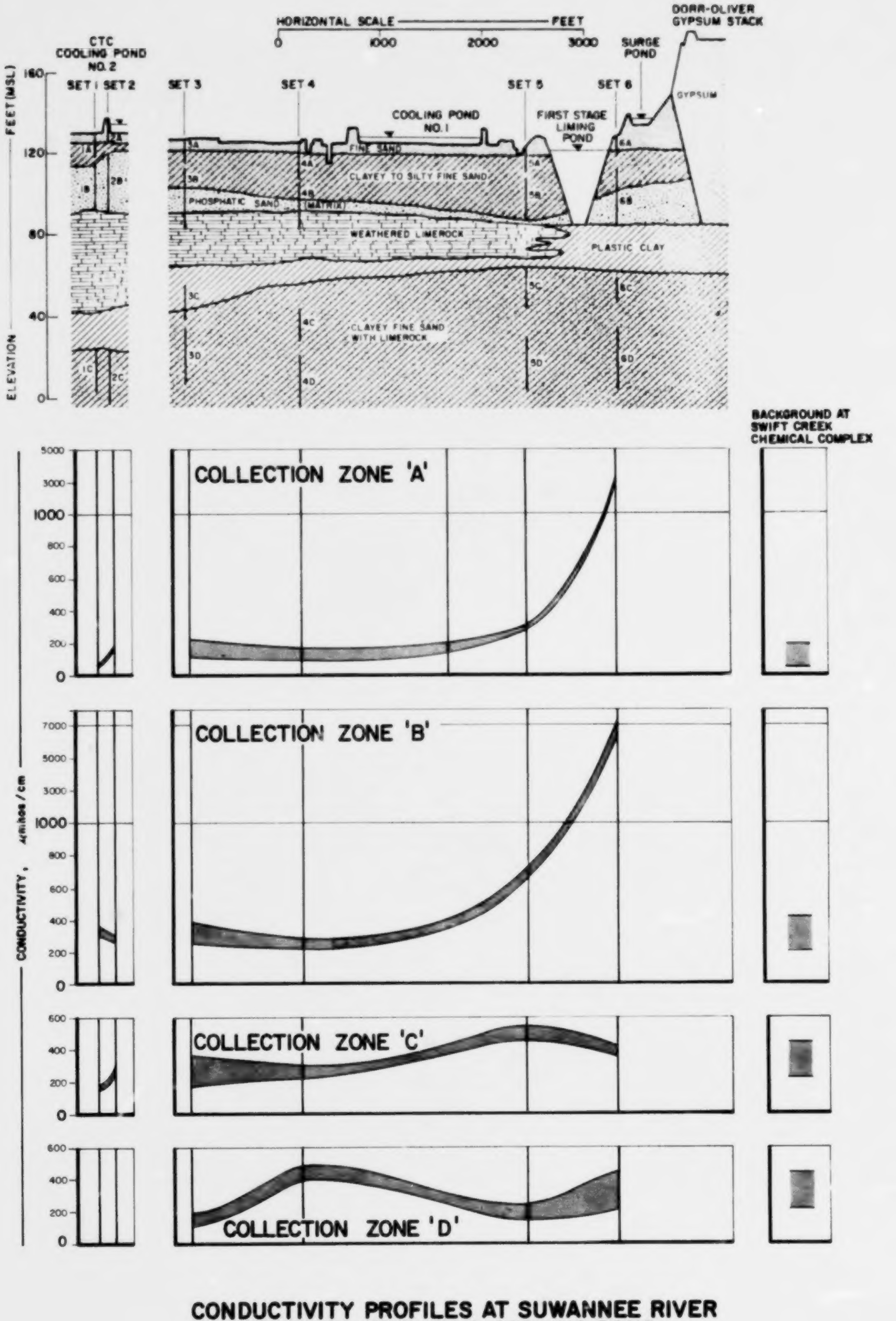
ORTHO-PHOSPHATE CONCENTRATION PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-13



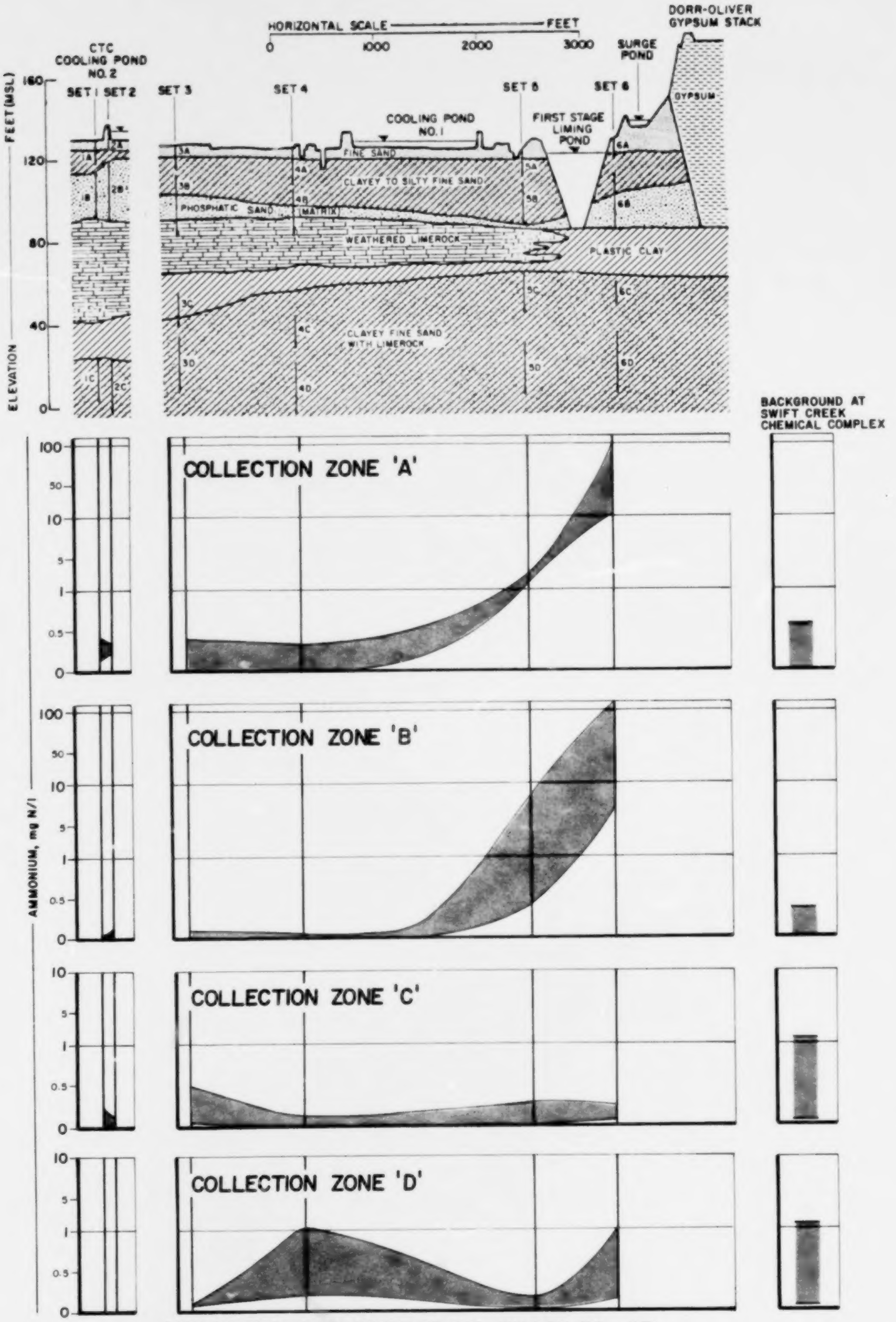
TOTAL PHOSPHATE CONCENTRATION PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-14



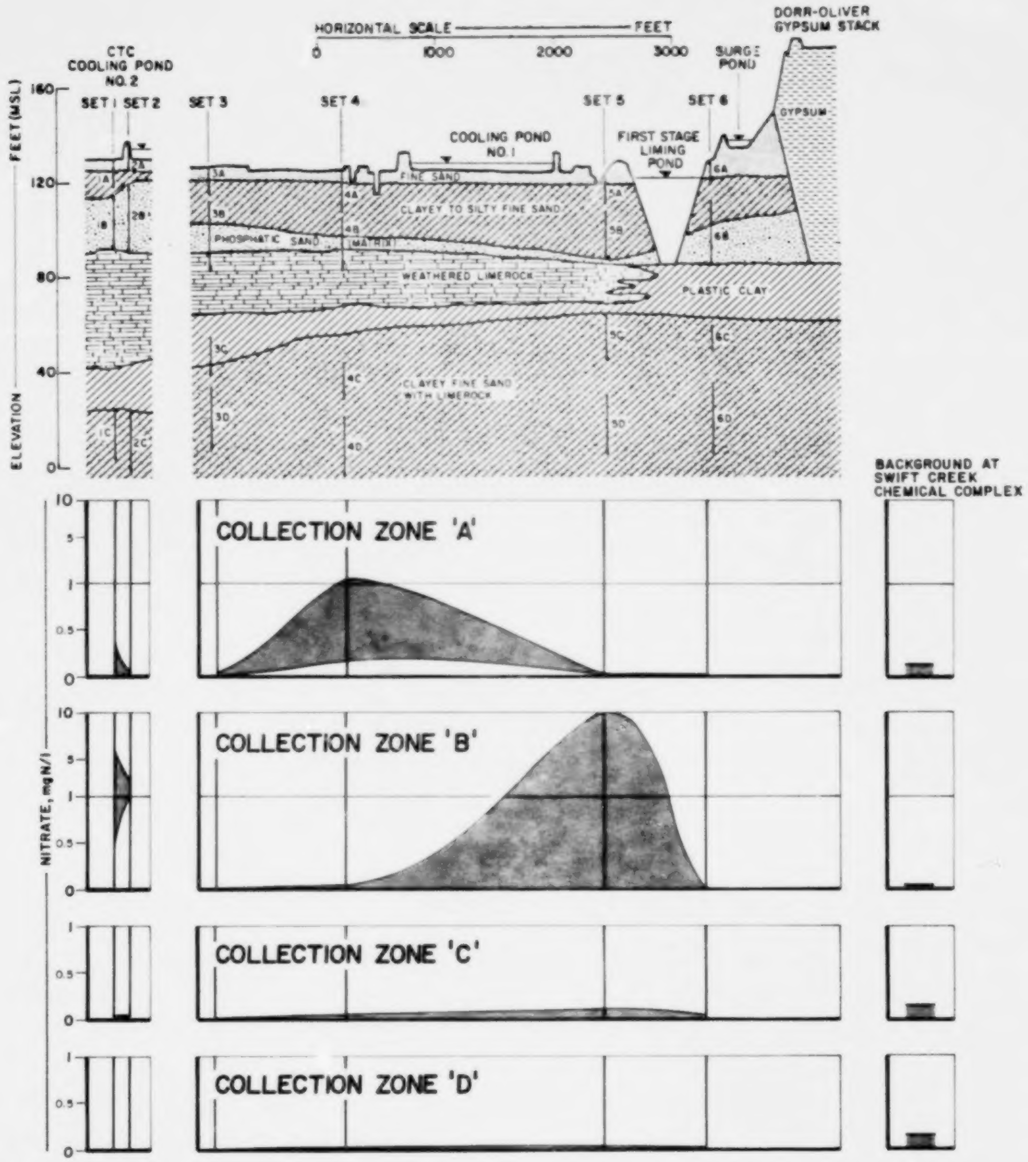
CONDUCTIVITY PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-15



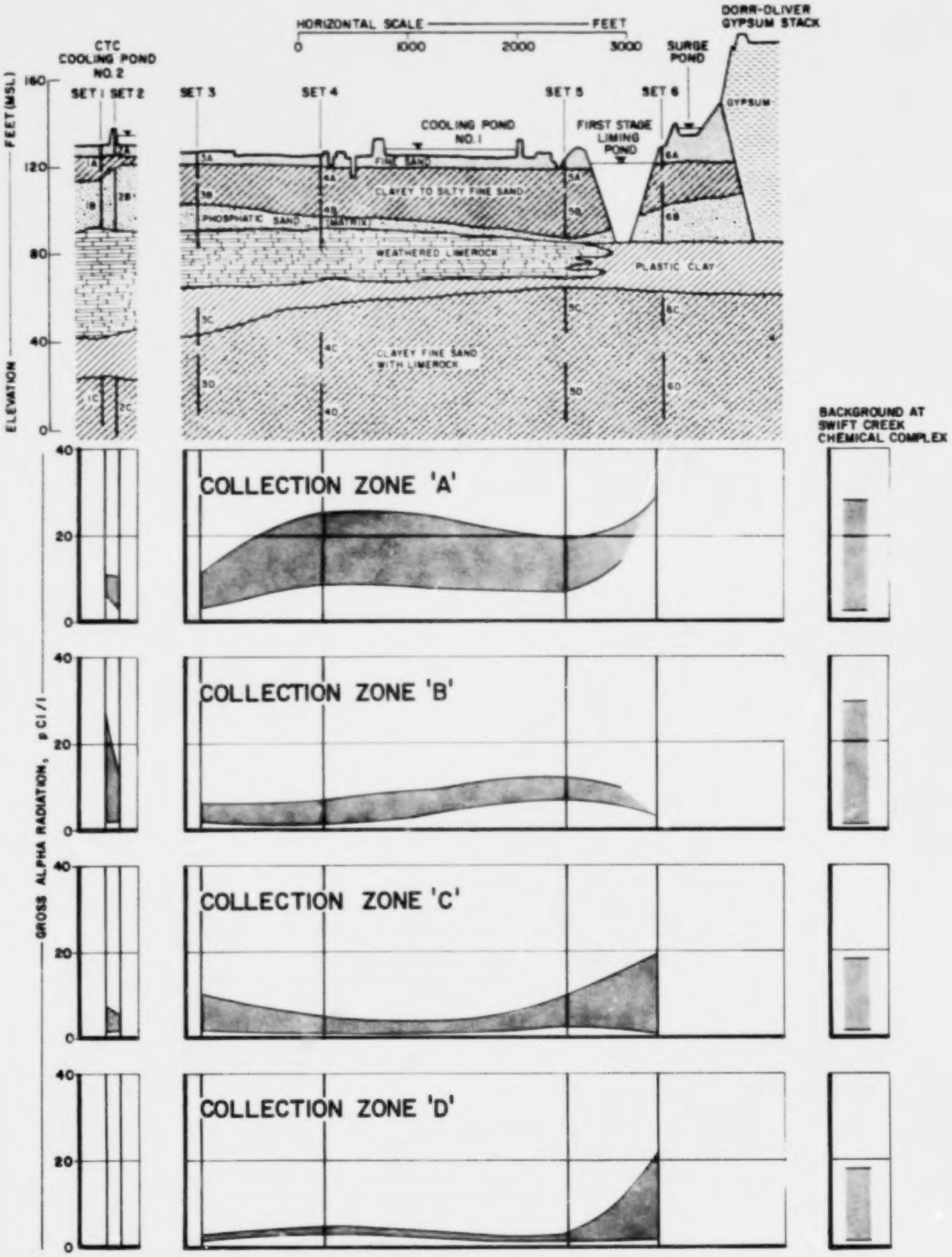
AMMONIUM CONCENTRATION PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-16



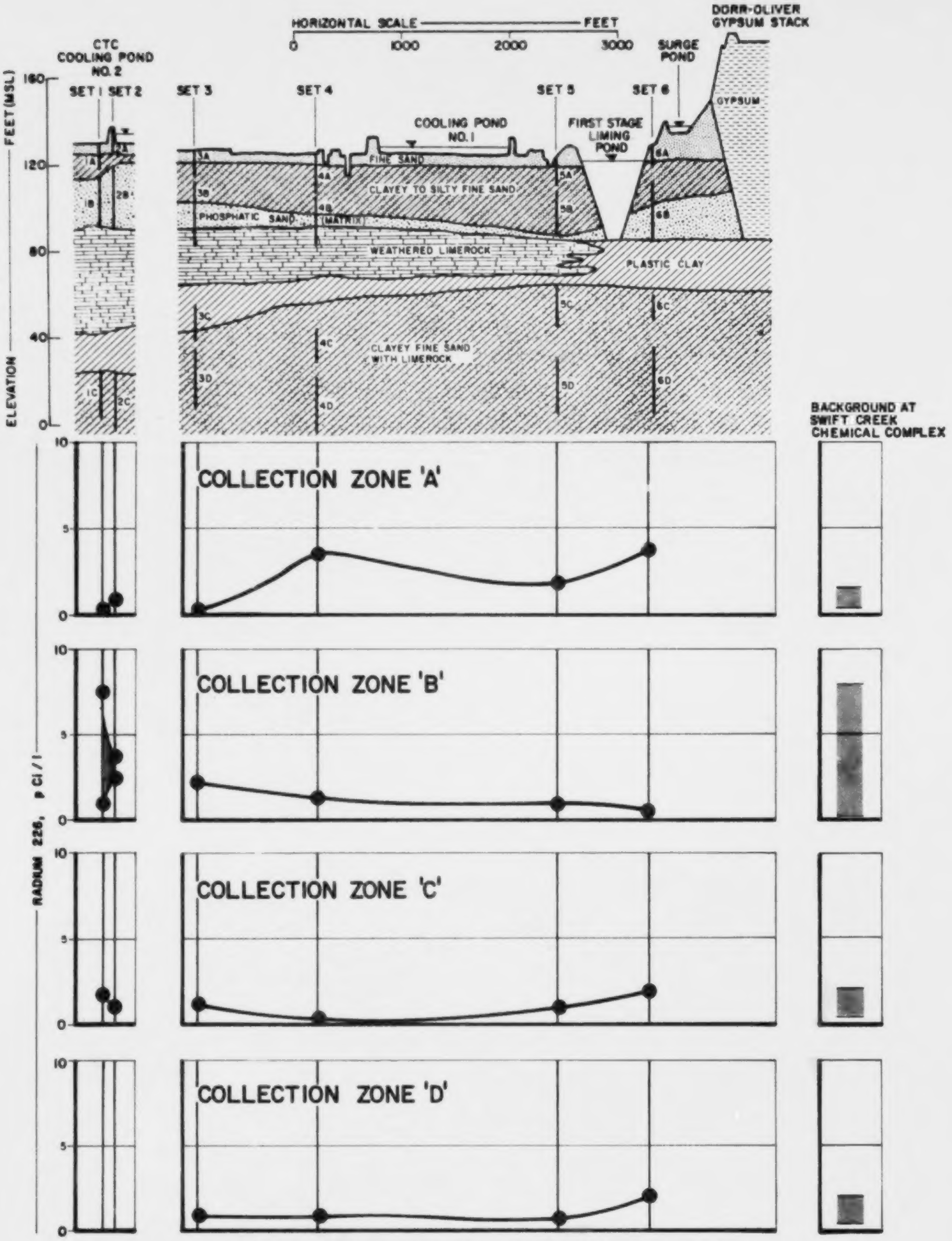
NITRATE CONCENTRATION PROFILES AT
SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-17



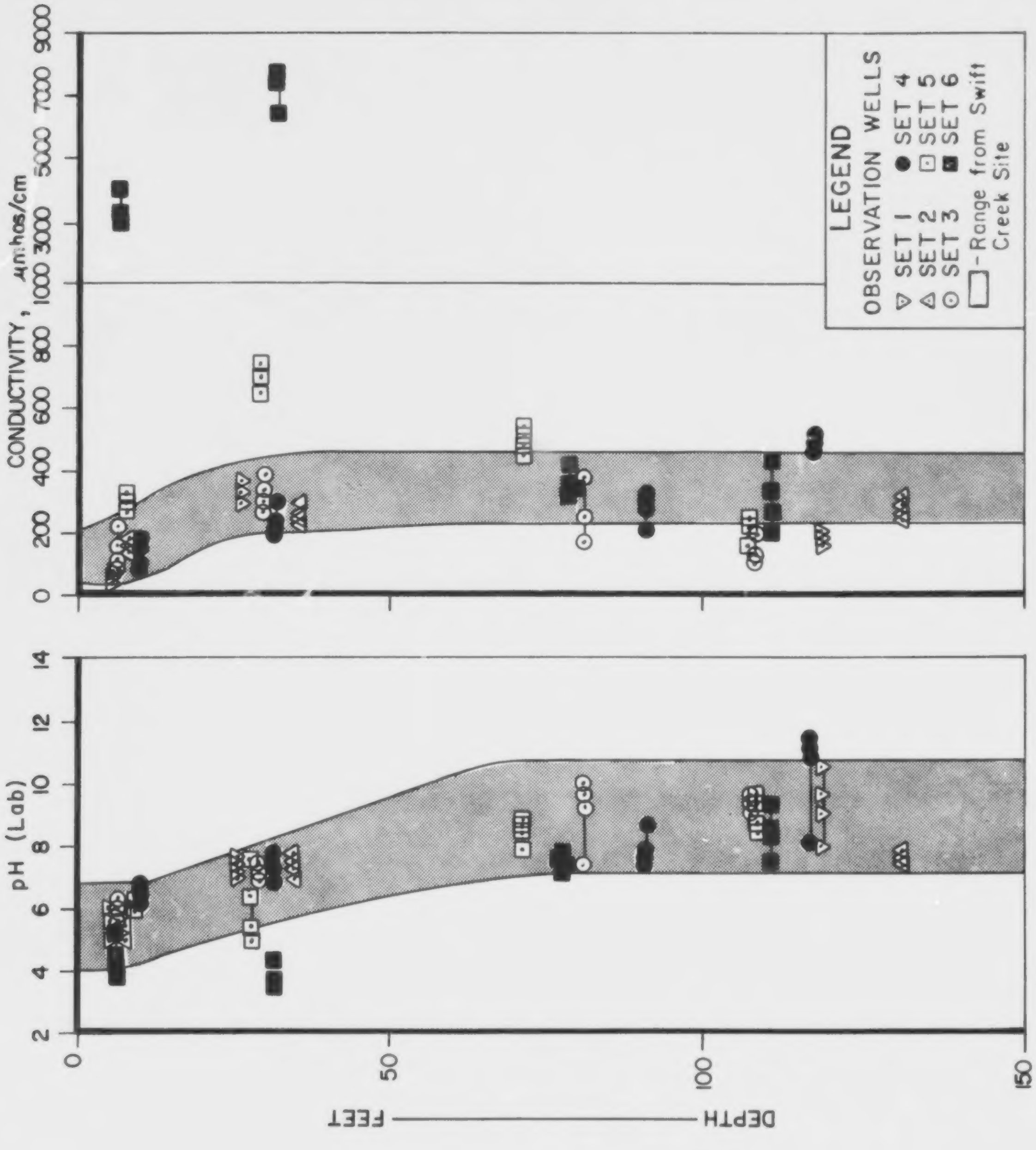
GROSS ALPHA RADIATION PROFILES AT SUWANNEE RIVER GYPSUM STACK AND COOLING POND

FIGURE 3.2-18



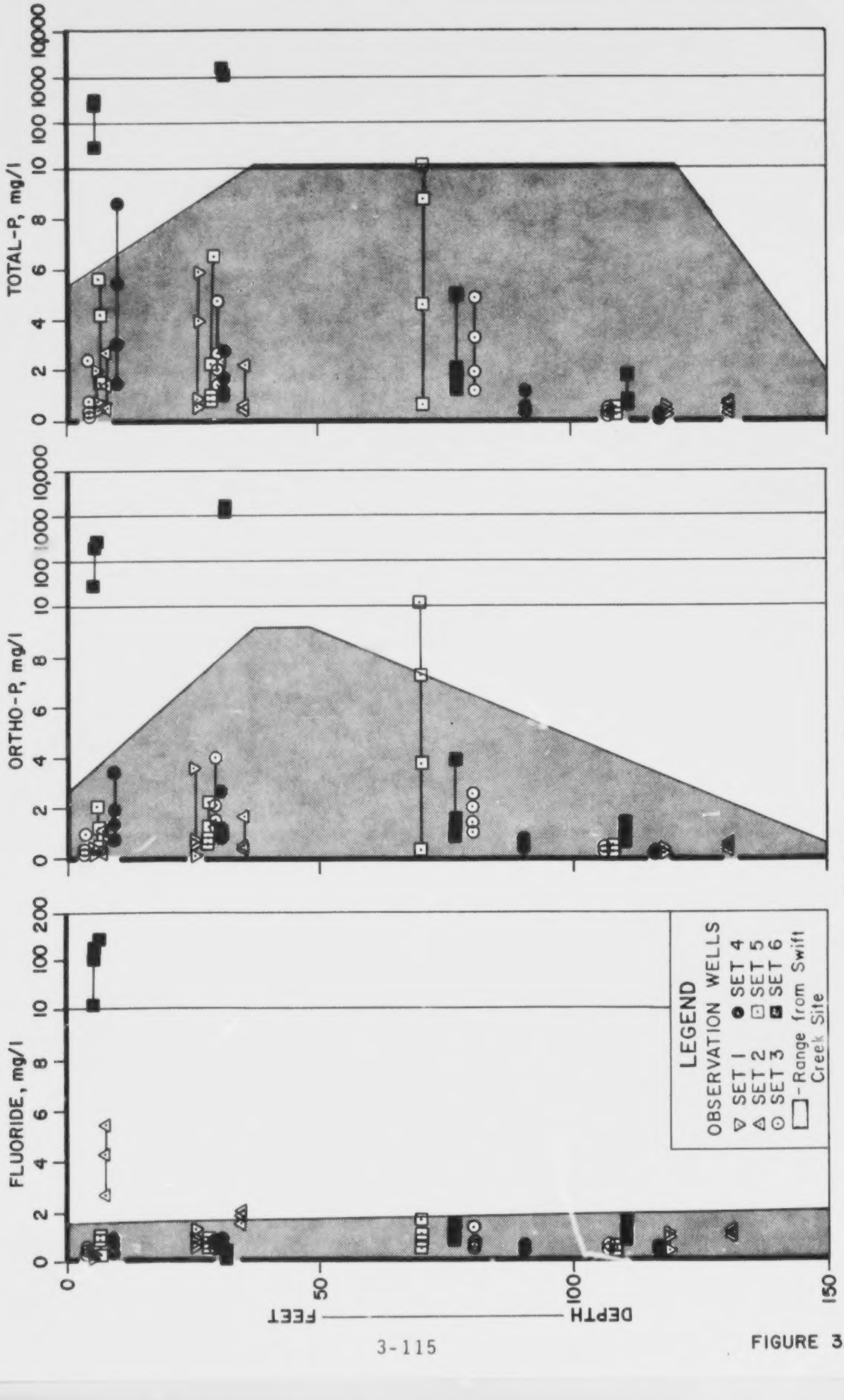
RADIUM 226 PROFILES AT SUWANNEE RIVER
GYPSUM STACK AND COOLING POND

FIGURE 3.2-19



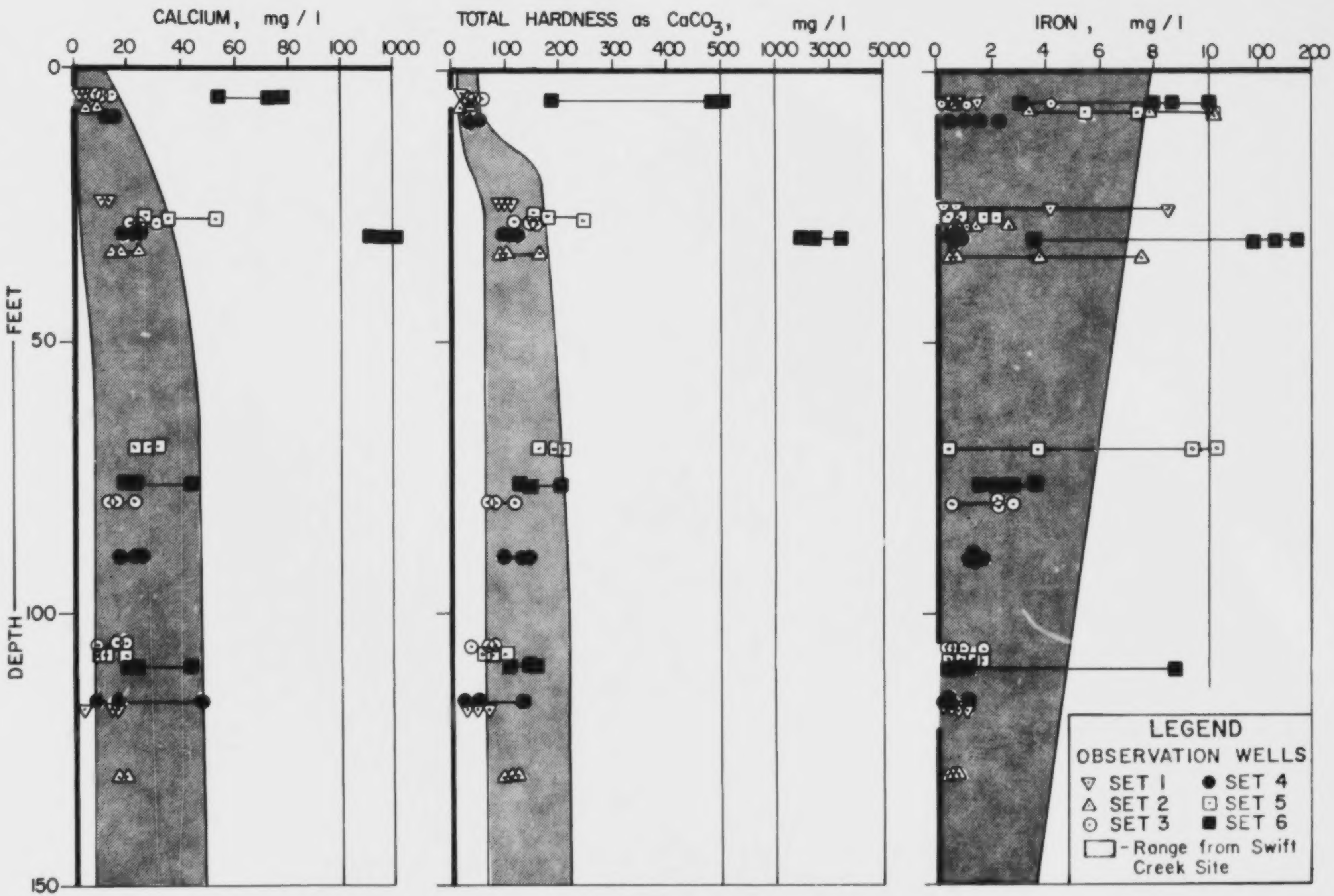
pH AND CONDUCTIVITY PROFILES
AT SUWANNEE RIVER CHEMICAL PLANT

FIGURE 3.2-20



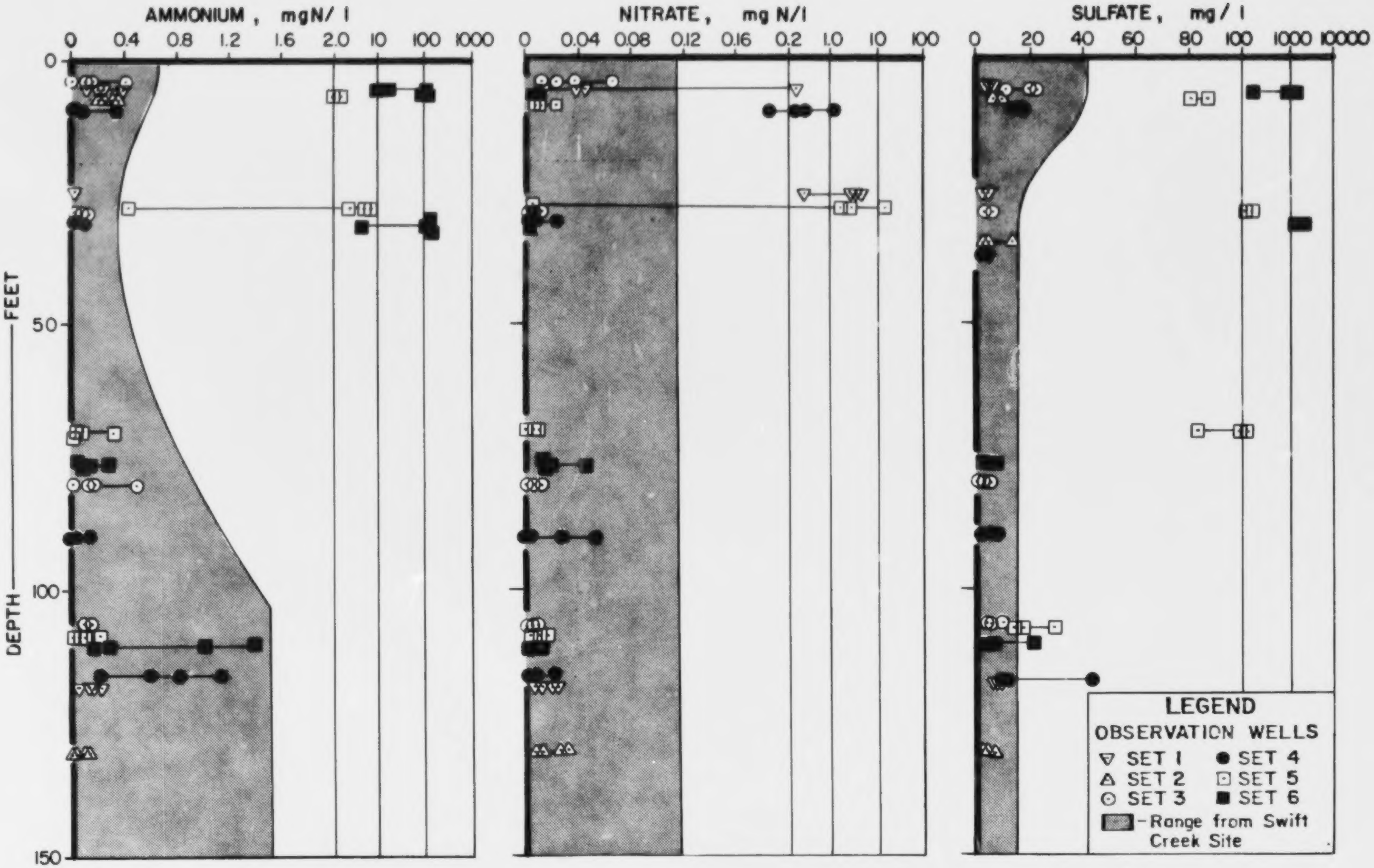
FLUORIDE AND PHOSPHATE CONCENTRATION PROFILES AT SUWANNEE RIVER CHEMICAL PLANT

FIGURE 3.2-21



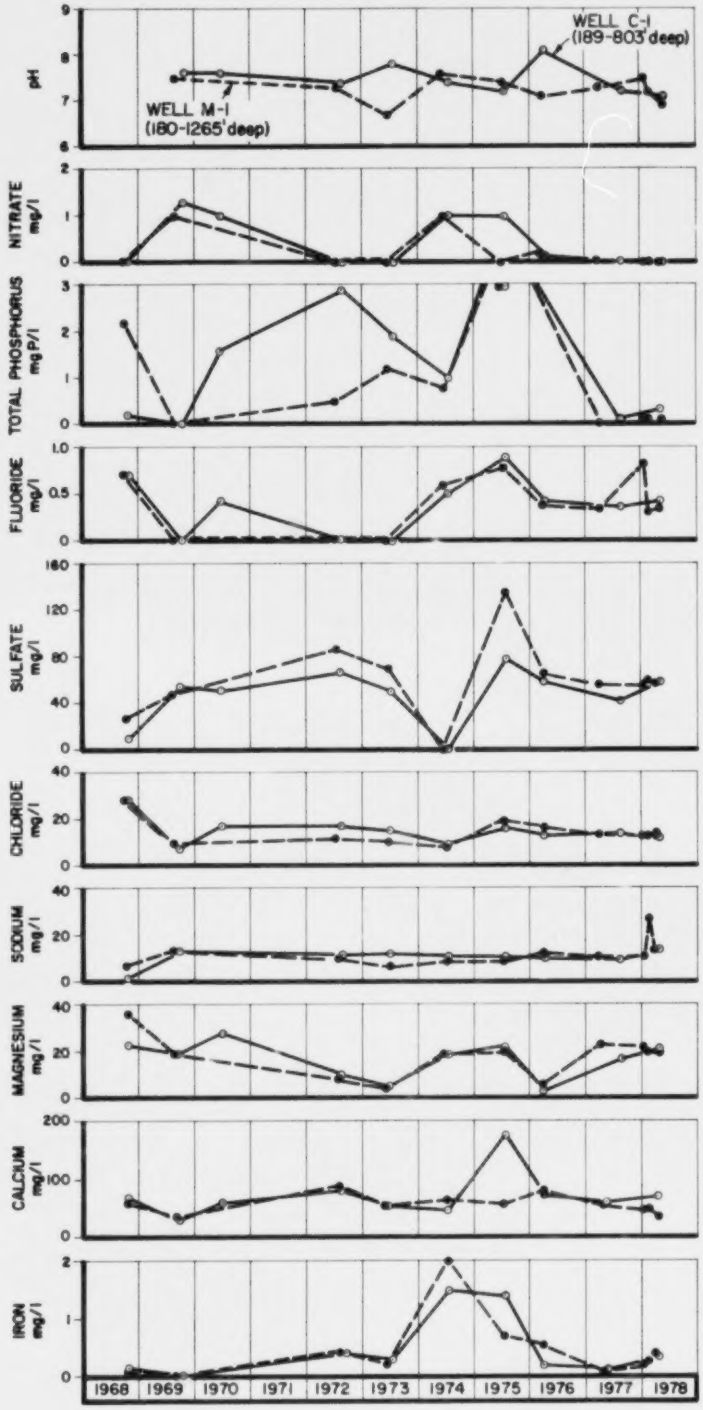
CALCIUM, TOTAL HARDNESS AND IRON CONCENTRATION PROFILES AT SUWANNEE RIVER CHEMICAL PLANT

FIGURE 3.2 - 22



AMMONIUM, NITRATE AND SULFATE CONCENTRATION PROFILES AT SUWANNEE RIVER CHEMICAL PLANT

FIGURE 3.2 - 23



TEMPORAL VARIATIONS OF WATER QUALITY IN FLORIDAN AQUIFER
AT EXISTING SUWANNEE RIVER PLANT

FIGURE 3.2-24

APPENDIX A3.2.1

GROUNDWATER QUALITY DATA AT EXISTING SUWANNEE RIVER PLANT

TABLE A3.2-1

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELL SET 1

Well Number	1-A				1-B				1-C			
Depth of Collection Zone	1-11'				13-38'				107- 129			
Sample Set	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z
Date Sampled	2/7/78	2/23/78	4/13/78	4/18/78	1/27/78	2/23/78	4/18/78	4/18/78	2/7/78	2/23/78	4/18/78	4/18/78
Water Level Elevation	126.4	125.9	125.4	125.4	--	126.9	126.2	126.2	69.7	65.1	62.4	62.4
Sample Number	8978	9048	9354	9355	8944	9050	9356	9357	8980	9052	9358	9359
Temperature °C	17	16.2	20	--	18	16.5	20.5	--	17	18.2	21	--
Color (APHA Units)	4	7	55	2	2	1	0	0	0	0	1	0
pH (Field)	6.5	--	--	--	6.7	--	--	--	7.1	--	--	--
(Lab)	7.3?	5.0	5.6	5.9	7.5	7.2	7.1	7.2	7.9	9.5	10.4	8.9
NUTRIENTS, mg/l												
Nitrogen-N												
Ammonium	0.21	0.41	0.12	0.24	<0.02	<0.02	<0.02	<0.02	0.12	0.21	0.05	0.12
Nitrate	0.013	0.043	0.354	0.038	0.49	5.7	5.40	5.50	0.02	0.008	0.007	0.020
Organic Dissolved	0.09	0.12	0.23	0.18	0.10	0.11	0.04	<0.02	<0.02	0.08	0.07	0.22
Phosphates-P												
Ortho	0.27	0.10	0.140	0.204	0.12	3.50	0.548	0.460	0.30	0.180	0.186	0.116
Total Phosphorus	1.87	0.52	0.28	0.58	3.82	5.85	0.80	0.51	0.38	0.520	0.23	0.17
Dissolved Organic Carbon	12.5	13.5	5.0	9.0	19.5	14.5	5.5	4.0	11.5	13.0	1.0	5.5
MAJOR CONSTITUENTS, mg/l												
Iron	1.54	0.61	0.83	0.51	4.05	8.4	0.56	0.09	1.10	0.41	0.75	0.20
Calcium	59.0	2.0	2.1	2.1	66.0	11.1	10.8	10.6	69.0	3.9	14.8	13.7
Magnesium	24.8	1.3	1.3	1.1	30.2	16.6	16.0	14.6	28.0	6.0	1.4	8.0
Sodium	7.7	4.2	5.5	3.9	8.8	11.6	15.2	15.4	7.7	11.7	8.3	9.7
Potassium	2.1	1.9	1.31	0.72	1.62	3.5	0.96	0.90	1.6	10.9	8.13	4.66
Sulfate	14	5.2	7.0	4.4	15	3.1	4.0	2.2	13	8.9	10	8.5
Sulfides	0.14	0.40	0.40	<0.02	0.2	0.55	0.25	<0.02	0.02	1.09	0.41	<0.02
Chloride	9.6	9.6	7.5	5.5	9.0	1.2	17.0	17	10	6.0	4.5	6.0
Fluoride	0.30	0.12	0.19	0.16	0.57	1.2	0.64	0.82	0.34	0.88	1.0	0.83
Strontium	0.18	<0.13	<0.05	<0.05	<0.15	0.15	<0.05	<0.05	0.18	0.20	0.09	0.06
Dissolved Solids	270	53	54	67	168	238	267	231	306	104	74	130
Total Solids	418	180	64	83	620	556	270	232	372	302	83	154
Hardness (Total)	250	10	11	10	289	96	93	87	288	34	43	67
Alkalinity ($CaCO_3$)	249	12	11	18	241	149	118	105	276	76	58	98
Conductivity (μmhos/cm @ 25°C)	477?	51	56	71	473?	330	293	359	512?	159	179	191
TRACE METALS, mg/l												
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	0.009	0.006	0.004	0.003	0.022	0.046	0.004	<0.002	0.004	0.006	0.009	<0.002
Manganese	0.66	0.008	0.017	0.032	0.122	0.100	0.041	0.014	0.46	0.024	0.018	0.031
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.002	<0.0002	<0.0002
Zinc	0.24	0.015	0.023	0.013	0.348	0.13	0.010	0.013	0.25	0.034	0.013	0.034
RADIO-CHEMICAL DATA, pCi/l												
Gross Alpha Radiation	6.6	10.4	--	--	8.8-28.6	5.4	--	<3.0	7.5	<2.[illegible]	--	<2.4
Radium 226	0.3	--	--	--	0.8-7.5	--	--	--	1.5	--	--	--

Locations shown in Figures 3.2-7 and 3.2-8

TABLE A3.2-1
(continued)

SUWANNEE RIVER PLANT
GROUNDWATER QUALITY DATA
OBSERVATION WELL SET 2

Well Number	2-A			2-B				2-C			
Depth of Collection Zone	2-13'			20-49'				117-144'			
Sample Set	W	X	Z	W	X	Y	Z	W	X	Y	Z
Date Sampled	2/7/78	2/23/78	4/18/78	1/24/78	2/23/78	4/17/78	4/17/78	2/7/78	2/23/78	4/17/78	4/17/78
Water Level Elevation	127.2	127.2	126.1	128.0	127.7	127.2	127.2	86.2	87.0	65.7	65.7
Sample Number	8981	9054	9353	8934	9056	9349	9350	8982	9058	9351	9352
Temperature °C	16	17.5	22	19.8	19	20.5	--	16	19	20	--
Color (APHA Units)	12	17	7	2	4	0	1	7	2	1	1
pH (Field)	5.3	--	--	6.4	--	--	--	6.5	--	--	--
(Lab)	5.9	5.4	5.0	6.9	7.0	7.4	7.7	7.5	7.5	7.6	7.7
NUTRIENTS, mg/l											
Nitrogen-N											
Ammonium	0.24	0.33	0.22	0.11	0.13	<0.02	<0.02	0.10	0.09	<0.02	<0.02
Nitrate	0.005	<0.005	0.007	2.23	2.04	1.12	1.16	0.007	0.007	0.028	0.023
Organic Dissolved	0.33	0.14	0.10	0.23	0.25	<0.02	0.10	0.05	<0.02	0.08	<0.02
Phosphates-P											
Ortho	1.03	0.176	0.153	16.9?	1.58	0.387	0.387	0.55	0.160	0.300	0.368
Total Phosphorus	2.60	0.344	1.35	20.2?	2.14	0.41	0.43	0.64	0.220	0.40	0.51
Dissolved Organic Carbon	21.0	17.0	5.5	33.5	26.5	1.5	3.5	17.0	11.0	2.5	2.5
MAJOR CONSTITUENTS, mg/l											
Iron	7.8	3.4	18	7.4	3.7	0.64	0.46	0.69	0.54	0.45	0.41
Calcium	31.5	5.7	4.6	49	16.2	43.2	14.4	40.0	17.7	17.1	17.0
Magnesium	6.2	2.6	1.9	22.6	13.8	12.9	13.2	17.3	14.9	15.0	15.3
Sodium	7.0	5.4	5.5	5.4	8.3	4.6	5.5	6.6	9.5	6.1	6.2
Potassium	2.6	0.88	0.48	1.56	1.3	0.24	0.36	1.2	0.96	0.48	0.48
Sulfate	32.0	6.1	10	5.0	14.0	3.6	3.6	12	6.6	4.8	4.7
Sulfides	0.31	0.24	--	0.04	0.72	<0.02	<0.02	0.55	1.05	<0.02	<0.02
Chloride	7.1	9.1	8.5	7.5	10	11	11	7.1	5.0	5.5	5.0
Fluoride	5.4	4.2	2.6	1.9	1.5	1.50	1.50	0.95	1.0	1.10	1.0
Strontium	0.35	0.13	<0.05	0.17	0.13	<0.05	<0.05	0.10	<0.13	<0.05	<0.05
Dissolved Solids	134	90	58	162	192	176	167	174	125	198	150
Total Solids	778	313	205	906	380	204	178	234	180	224	160
Hardness (Total)	104	25	19	216	97	161	90	171	106	105	106
Alkalinity ($CaCO_3$)	40	32	2.0	112	124	112	114	160	148	143	143
Conductivity (μmhos/cm @ 25°C)	171	151	160	260	295	244	251	315	300	277	269
TRACE METALS, mg/l											
Arsenic	<0.02	<0.02	<0.02	< 0.02	<0.02	<0.02	<0.02	< 0.02	<0.02	<0.02	<0.02
Chromium	0.043	<0.004	0.015	0.04	0.020	0.004	0.003	0.003	0.004	0.003	0.003
Manganese	0.025	0.18	0.042	0.105	0.054	0.021	0.040	0.062	0.046	0.041	0.043
Mercury	<0.0002	<0.0002	<0.0002	< 0.0002	<0.0002	<0.0002	<0.0002	< 0.0002	0.0002	<0.0002	<0.0002
Zinc	0.03	0.011	0.063	0.028	0.034	0.011	0.014	0.039	<0.024	0.027	0.013
RADIO-CHEMICAL DATA, pCi/l											
Gross Alpha Radiation	10.1	2.9	4.7	5.8-12.7	6.3	--	2.0	5.9	<2.1	--	<2.2
Radium 226	0.9	--	--	2.5-3.7	--	--	--	0.9	--	--	--

Locations shown in Figures 3.2-7 and 3.2-8

TABLE A3.2-1
(continued)

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELL SET 3

Well Number	3-A				3-B				3-C				3-D			
Depth of Collection Zone	1-11'				15-43'				72-88'				93-120'			
Sample Set	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z
Date Sampled	1/24/78	2/23/78	4/13/78	4/13/78	2/8/78	2/28/78	4/13/78	4/13/78	1/20/78	2/23/78	4/13/78	4/13/78	4/8/78	2/23/78	4/13/78	4/13/78
Water Level Elevation	125.3	126.2	126.3	126.3	124.6	124.9	126.0	126.0	70.0	68.8	67.2	67.2	61.6	65.3	64.4	64.4
Sample Number	8935	9077	9279	9280	9019	9078	9281	9282	8915	9080	9283	9284	9021	9082	9285	9286
Temperature °C	18	14.2	19	--	18	18	19	--	12	18.8	20	21	18	18	20	20
Color (APHA Units)	55	7	5	5	2	1	1	0	7	1	1	2	1	1	2	2
pH (Field)	6.2	6.4	--	--	6.9	6.8	--	--	6.7	10.4	--	--	10.2	10.5	--	--
(Lab)	6.3	5.6	5.9	5.9	7.3	7.1	6.9	7.2	7.3	9.9	9.2	9.6	11.0	9.5	9.4	9.0
NUTRIENTS, mg/l																
Nitrogen-N																
Ammonium	0.41	0.10	<0.02	0.14	0.10	<0.02	0.04	0.05	0.49	0.16	0.02	0.09	0.07	0.10	0.08	0.09
Nitrate	0.065	0.037	0.010	0.022	0.009	<0.005	0.010	0.010	< .005	0.006	0.013	<0.005	0.008	0.006	0.007	<0.005
Organic Dissolved	0.06	0.15	0.23	0.11	<0.02	0.02	0.07?	0.08	0.29	0.08	0.09	0.09	0.43	<0.02	0.09	0.08
Phosphates-P																
Ortho	0.253	0.070	0.116	0.933	2.04	1.16	3.98	1.51	2.50	1.94	1.36	0.913	0.35	0.120	0.340	0.20
Total Phosphorus	0.696	0.095	0.25	2.30	2.62	1.36	4.65	1.92	4.80	3.18	1.83	1.07	0.38	0.140	0.40	0.20
Dissolved Organic Carbon	285	14.5	11.0	9.0	7.5	5.0	6.0	4.5	43.0	11.0	5.0	6.5	10.5	6.5	5.0	5.0
MAJOR CONSTITUENTS, mg/l																
Iron	0.35	0.73	1.02	4.3	1.26	0.89	2.6	0.65	2.2	2.6	2.2	0.48	1.64	0.91	0.29	0.44
Calcium	31?	9.9	12.2	8.7	54.5?	28.5	20.1	22.4	59.5?	21.0	15.8	12.5	80.5	18.0	7.2	14.4
Magnesium	5.4	2.9	4.7	2.8	24.9	18.9	14.8	18.3	34.2	3.4	16.9	10.8	10.1	5.7	3.8	8.9
Sodium	4.7	6.2	10.6	9.0	4.8	4.1	6.1	4.1	14	19.0	15.7	18.2	10.2	9.5	13.3	10.1
Potassium	4.8	0.64	0.60	0.60	1.5	0.80	0.96	0.72	3.78	8.3	7.4	8.6	2.9	1.9	3.12	1.67
Sulfate	40	23	16	21	6.0	5.0	4.5	4.4	71	4.8	2.7	<1.0	40	11	7.1	7.6
Sulfides	<0.01	0.75	0.55	0.07	<0.01	0.22	0.14	0.04	0.62	0.65	0.21	0.12	0.08	0.48	<0.02	0.19
Chloride	10	7.1	17.0	12.0	8.2	8.1	8.1	8.1	13	6.1	4.5	6.1	10	7.1	7.1	6.1
Fluoride	0.33	0.51	0.17	0.12	0.52	0.50	0.46	0.39	0.72	1.3	0.56	0.68	0.52	0.38	0.39	0.35
Strontium	<0.15	0.15	0.06	<0.05	0.15	<0.13	0.06	<0.05	0.22	1.40	0.17	0.18	0.48	0.18	0.12	0.08
Dissolved Solids	256	33	144	74	174	150	149	167	306	114	142	156	82	92	84	78
Total Solids	414	41	196	128	354	208	358	242	606	606	410	227	390	130	129	132
Hardness (Total)	100	37	50	33	239	149	111	131	290	67	109	76	243	68	34	73
Alkalinity (CaCO$_3$)	53	13	15	16	212	188	143	170	202	139	131	118	102	90	45	96
Conductivity (µmhos/cm @ 25°C)	225	120	159	114	390	332	258	296	549?	369	249	170	415?	195	113	110
TRACE METALS, mg/l																
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	0.004	0.004	0.003	0.006	0.012	<0.004	0.019	0.005	0.017	0.020	0.02	0.005	0.009	0.006	0.003	0.004
Manganese	0.026	0.016	0.016	0.028	0.078	0.070	0.093	0.004	0.086	0.036	0.073	0.02	0.021	0.014	0.009	0.012
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.008	0.048	0.019	0.020	0.03	0.026	0.028	0.012	0.033	0.114	0.030	0.012	0.014	0.028	0.008	0.009
RADIO-CHEMICAL DATA, pCi/l																
Gross Alpha Radiation	<3.4	3.5	——	11.0	6.0	2.2	——	5.7	10.1	<2.5	——	2.7	<2.9	2.0	——	<2.3
Radium 226	0.2	——	——	——	2.2	——	——	——	1.1	——	——	——	0.9	——	——	——

Locations shown in Figures 3.2-7 and 3.2-8

TABLE A3.2-1
(continued)

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELL SET 4

Well Number	4-A				4-B				4 C				4 D			
Depth of Collection Zone	1-18'				20-42'				82-98'				105-129'			
Sample Set	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z
Date Sampled	1/24/78	3/1/78	4/13/78	4/13/78	2/9/78	3/1/78	4/13/78	4/13/78	1/20/78	3/1/78	4/13/78	4/13/78	2/8/78	3/1/78	4/13/78	4/13/78
Water Level Elevation	124.2	122.8	121.7	121.7	122.3	122.5	121.5	121.5	76.4	73.8	69.9	69.9	66.0	63.2	61.6	61.6
Sample Number	8937	9083	9287	9288	9020	9084	9289	9290	8917	9085	9291	9292	9022	9086	9293	9294
Temperature °C	18	15	17	17	18	18.6	17	--	18	18.5	19	--	17	18.8	19	--
Color (APHA Units)	6	18	2	1	1	1	0	1	7.0	0	1	0	6	2	2	1
pH (Field)	6.0	5.8	6.5	6.3	7.1	7.8	6.8	--	7.0	8.2	8.4	--	6.7	9.0	6.0	--
(Lab)	6.1	6.7	6.3	6.4	7.6	6.8	7.6	7.3	7.5	7.3	8.6	7.6	8.0	11.3	11.1	11.0
NUTRIENTS, mg/l																
Nitrogen-N																
Ammonium	0.32	0.02	0.06	<0.02	0.06	<0.02	<0.02	<0.02	0.05	0.11	0.04	<0.02	0.20	1.11	0.79	0.59
Nitrate	0.185	1.42	0.452	0.350	<0.005	<0.005	0.022	0.007	0.053	<0.005	0.027	<0.005	0.005	0.020	<0.005	<0.005
Organic Dissolved	0.28	0.35	0.16?	0.18	0.02	0.02	0.03	0.04	0.15	<0.02	<0.02	<0.02	<0.02	0.08	0.10	0.10
Phosphates-P																
Ortho	3.34	1.92	1.30	0.660	1.17	0.760	0.986	2.62	0.76	0.480	0.386	0.300	0.11	<0.010	0.070	0.060
Total Phosphorus	8.6	5.36	2.97	1.40	1.51	0.850	1.00	2.65	1.08	0.520	0.39	0.30	0.12	0.110	0.16	0.07
Dissolved Organic Carbon	24.0	11.0	5.0	4.5	8.5	6.5	5.0	6.5	13	7.5	2.5	4.0	11.5	9.0	5.5	6.5
MAJOR CONSTITUENTS, mg/l																
Iron	2.19	1.5	0.92	0.39	0.67	0.43	0.26	0.25	1.32	1.6	1.2	1.2	1.04	0.25	0.28	0.38
Calcium	24.5?	12.0	13.3	12.0	39.0?	21.9	23.1	17.8	37?	23.7	17.4	21.8	60.5?	46.8	15.2	6.7
Magnesium	3.6	1.6	1.9	1.9	16.0	11.7	12.2	11.1	17.7	17.6	12.2	17.4	23.7	1.7	0.70	0.90
Sodium	5.0	14.2	5.8	5.5	3.7	4.9	6.2	3.7	4.5	6.6	4.2	3.7	11.2	92.6	20.7	21.5
Potassium	1.98	10.5	1.08	1.43	2.6	1.4	0.72	0.60	1.18	0.96	1.2	0.72	1.9	70.4	31.8	25.5
Sulfate	33	15	17	16	9.2	3.8	2.6	4.4	3.1	6.4	6.2	3.3	47	45	11	11
Sulfides	<0.01	0.13	0.30	0.32	<0.01	0.11	0.56	0.46	0.49	0.06	0.38	0.43	0.04	0.10	0.38	0.42
Chloride	7.0	5.6	4.0	4.2	5.6	5.0	3.5	4.5	5.6	4.6	5.8	4.5	13	8.1	7.0	8.0
Fluoride	0.48	0.80	0.23	0.26	0.50	0.54	0.78	0.64	0.41	0.36	0.48	0.36	0.37	0.46	0.39	0.39
Strontium	0.22	0.23	<0.05	0.06	<0.08	<0.13	<0.05	0.06	<0.15	<0.13	0.06	<0.05	0.24	1.72	0.78	0.54
Dissolved Solids	62	154	75	26	74	126	141	134	112	200	152	180	282	350	261	217
Total Solids	454	202	196	60	178	179	144	138	225	234	218	210	310	452	312	302
Hardness (Total)	76	37	41	33	163	103	108	90	165	132	94	126	249	124	41	20
Alkalinity ($CaCO_3$)	32	52	30	26	146	13	128	113	136	173	122	166	211	271	134	105
Conductivity (µmhos/cm @ 25°C)	149	172	113	99	290	234	220	212	296	300	214	284	490	1100?	490	400
TRACE METALS, mg/l																
Arsenic	<0.02	<0.02	<0.02	<0.02	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.021	<0.02	<0.02
Chromium	0.02	0.012	0.008	0.004	0.006	<0.004	<0.002	<0.002	0.014	0.006	0.007	0.005	<0.002	<0.004	0.005	<0.002
Manganese	0.041	0.020	0.045	0.021	0.03	0.032	0.031	0.023	0.038	0.032	0.027	0.036	0.044	<0.006	0.015	0.019
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	<0.004	0.042	0.022	0.016	0.013	0.011	0.008	0.005	0.034	0.011	0.049	0.011	0.073	0.053	0.035	0.017
RADIO-CHEMICAL DATA, pCi/l																
Gross Alpha Radiation	25.6	9.6	--	8.4	7.1	<1.8	--	<1.6	2.3	<1.6	--	5.1	<5.3	4.2	--	2.7
Radium 226	3.4	--	--	--	1.3	--	--	--	0.3	--	--	--	0.9	--	--	--

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Locations shown in Figures 3.2-7 and 3.2-8

TABLE A3.2-1

(continued)

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELL SET 5

Well Number	5-A			5-B				5-C				5-D			
Depth of Collection Zone	1-14'			17-40'				60-80'				95-119'			
Sample Set	W	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z
Date Sampled	2/24/78	4/14/78	4/14/78	2/7/78	2/24/78	4/14/78	4/14/78	1/24/78	2/24/78	4/14/78	4/14/78	2/7/78	2/24/78	4/14/78	4/17/78
Water Level Elevation	120.7	120.6	120.6	118.7	120.5	120.1	120.1	120.3	112.5	107.8	107.8	93.1	93.8	86.8	86.8
Sample Number	9064	9295	9296	8986	9065	9297	9298	8938	9066	9299	9300	8987	9067	9301	9302
Temperature °C	15	18.5	19	18.5	19.5	19	19.5	21	19.5	20.5	20.5	18	19	21.5	21
Color (APHA Units)	1	45	25	32	1	0	1	0	6	1	2	11	1	1	1
pH (Field)	--	--	--	6.6	--	--	--	6.4	--	--	--	8.5	--	--	--
(Lab)	6.1	6.1	6.0	7.5	6.3	5.0	5.4	7.0	7.3	7.3	7.5	9.1	8.4	9.2	8.7
NUTRIENTS, mg/l															
Nitrogen-N															
Ammonium	2.13	2.10	2.9	0.43	5.80	8.5	7.6	0.29	0.03	0.03	<0.02	0.18	0.08	0.05	0.03
Nitrate	0.022	0.007	0.007	<0.005	4.70	11.5	8.3	<0.005	0.050	0.113	0.075	0.015	0.005	0.010	0.005
Organic Dissolved	0.30	0.44	0.33	0.12	0.46	0.21	0.18	0.16	0.29	0.04	0.04	0.04	0.14	0.06	0.02
Phosphates-P															
Ortho	1.20	2.00	0.280	0.75	2.22	1.21	0.533	0.383	13.2	7.20	3.66	0.18	0.340	0.306	0.106
Total Phosphorus	5.47	4.10	1.45	0.90	6.45	2.23	0.72	0.568	15.4	8.75	4.50	0.24	0.440	0.46	0.15
Dissolved Organic Carbon	36.5	14.0	14.5	33.5	21.5	7.0	5.0	20.5	37.0	7.5	5.5	34.5	25.0	3.5	1.5
MAJOR CONSTITUENTS, mg/l															
Iron	7.5	15	5.5	1.98	1.6	0.65	0.27	0.34	14	9.3	3.6	1.22	1.5	0.28	0.80
Calcium	11.1	8.5	7.8	51.0	63.8	25.9	33.8	50	22.2	26.7	30.4	37	12.0	11.4	17.1
Magnesium	5.7	4.2	4.5	16.6	19.5	20.2	20.5	25.8	32.2	22.6	25.4	11.8	11.1	7.5	11.8
Sodium	37.2	26.0	30.0	9.1	66.1	30.4	32.2	19.7	30.6	16.8	20.2	5.2	5.0	7.5	4.7
Potassium	2.2	1.79	1.55	1.4	6.4	5.02	4.3	1.32	9.2	3.82	3.82	1.2	0.64	4.6	0.60
Sulfate	67	82	87	36	234	275	275	102	109	84	117	21	15	17	30
Sulfides	0.10	0.22	0.27	0.22	0.35	<0.02	0.81	<0.01	0.18	0.34	0.42	0.02	0.69	0.38	0.43
Chloride	14	18	18	11	9.1	9.5	9.0	9.5	11	9.0	9.5	7.1	3.0	5.5	6.0
Fluoride	0.23	0.90	0.80	0.40	0.42	0.74?	0.58	0.52	1.5	1.0	0.72	0.47	0.45	0.44	0.52
Strontium	<0.13	<0.05	<0.05	0.22	0.18	<0.05	<0.05	<0.15	0.30	<0.05	<0.05	0.18	<0.13	0.72	<0.05
Dissolved Solids	192	268	258	154	440	574	484	290	350	317	362	252	116	138	217
Total Solids	282	416	414	168	546	635	502	442	1410	1240	894	288	302	200	252
Hardness (Total)	51	39	38	196	240	148	169	231	188	160	181	141	76	59	91
Alkalinity ($CaCO_3$)	40	44	40	159	99	2.0	8.0	152	172	156	169	114	94	58	85
Conductivity (μmhos/cm @ 25°C)	298	283	314	380?	653	729	702	491	546	453	524	243	225	162	221
TRACE METALS, mg/l															
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	0.014	0.008	0.005	0.01	0.024	0.006	0.004	<0.003	0.140	0.11	0.039	0.005	0.008	0.004	0.004
Manganese	0.200	0.256	0.138	0.041	0.332	0.368	0.268	0.049	0.186	0.076	0.063	0.020	0.038	<0.006	0.023
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.021	0.013	0.009	0.024	0.028	0.027	0.022	0.01	0.054	0.100	0.026	0.015	0.052	0.025	0.033
RADIO-CHEMICAL DATA, pCi/l															
Gross Alpha Radiation	19.8	--	7.1	6.8	10.8	--	12.0	2.7	6.7	--	10.0	3.6	<2.6	--	<2.3
Radium 226	1.8	--	--	1.0	--	--	--	0.9	--	--	--	0.7	--	--	--

Locations shown in Figures 3.2-7 and 3.2-8

TABLE A3.2-1
(continued)

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OBSERVATION WELL SET 6

Well Number	6-A				6-B				6-C				6-D			
Depth of Collection Zone	1-11'				17-45'				71-82'				95-125'			
Sample Set	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z
Date Sampled	1/24/78	2/24/78	4/17/78	4/17/78	2/7/78	2/24/78	4/17/78	4/17/78	1/24/78	2/24/78	4/17/78	4/17/78	2/7/78	2/24/78	4/17/78	4/17/78
Water Level Elevation	123.5	123.1	123.9	123.9	122.6	122.6	124.0	124.0	70.9	67.4	65.2	65.2	56.6	57.9	54.7	54.7
Sample Number	8939	9068	9341	9342	8988	9069	9343	9344	8940	9087	9345	9346	8989	9070	9347	9348
Temperature °C	18	17	20.5	20.5	18	20	20.5	21	18	18.5	22	--	18.5	18.5	21	--
Color (APHA Units)	330	360	400	400	17	42	45	55	2	1	0	0	12	30	0	0
pH (Field)	4.4	--	5.4	--	6.7	--	--	--	6.7	6.4	--	--	6.7	--	--	--
(Lab)	4.2	4.4	5.2	3.8	7.2?	4.1	3.7	3.6	7.7	7.2	7.4	7.6	7.3	8.2	9.2	8.2
NUTRIENTS, mg/l																
Nitrogen-N																
Ammonium	25.5	104	13.0	103	7.2	220	198	222	0.25	0.06	0.13	0.04	1.37	1.00	0.26	0.16
Nitrate	<0.005	<0.005	0.010	<0.005	--	<0.005	<0.005	<0.005	0.045	0.017	0.017	0.016	<0.005	0.01	<0.005	<0.005
Organic Dissolved	6.6	6.90	3.76	7.4	--	1.80	1.20	1.77	0.12	<0.02	0.02	0.06	0.32	0.23	0.07	0.02
Phosphates-P																
Ortho	415	410	50	460	43.7?	2300	1550	2100	3.82	0.770	1.18	1.50	15?	1.30	0.572	0.527
Total Phosphorus	450	430	50	528	44?	2400	1600	2520	4.90	1.08	1.46	1.90	213*?	1.75	0.70	0.63
Dissolved Organic Carbon	355	365	13.5	28.0	2.0	815	47.5	49.0	18.0	--	3.5	2.0	27.5	19.5	2.5	3.5
MAJOR CONSTITUENTS, mg/l																
Iron	8.7	3.1	11.0	8.0	3.45	132	90	170	3.45	2.1	2.6	1.5	8.7	0.92	0.79	0.30
Calcium	167	71.7	52.6	75.7	84	510	778	994	62	42.5	19.0	20.9	101	42.5	22.4	21.3
Magnesium	69.2	73.1	11.8	74.1	18.6	143	118	194	30.4	20.8	19.3	20.2	27	13.0	7.5	12.2
Sodium	336	579	37.7	518	30.4	1140	828	966	5.5	16.2	5.34	5.3	19.4	12.4	6.4	5.3
Potassium	15.6	25.6	20.9	27.3	2.6	108	60.1	65.5	1.62	1.3	0.84	0.96	3.1	3.7	1.31	1.08
Sulfate	1190	1380	360	1550	122	2860	2900	2900	6.10	6.2	2.6	2.4	81	23	7.2	5.4
Sulfides	11.6	27.3	135	292	0.14	4.28	4.6	3.4	0.04	0.02	<0.02	<0.02	<0.01	0.61	0.09	<0.02
Chloride	--	47	46	50	12	42	39	43	5.5	5.1	5.0	5.5	11	6.5	6.0	6.5
Fluoride	107	140	18.0?	135	0.38	0.42	0.43	0.25	1.4	0.95	0.85	0.74	1.2	1.5	0.76	0.72
Strontium	0.70	0.58	0.09	0.12	0.22	0.18	<0.05	0.09	<0.15	<0.13	<0.05	<0.05	0.30	0.19	<0.05	<0.05
Dissolved Solids	3560	4330	1150	4330	200	12500	9350	12600	226	246	340	234	332	152	128	170
Total Solids	4790	4600	1300	4640	430	12900	9510	12900	578	302	372	246	892	262	148	172
Hardness (Total)	703	480	180	495	287	1860	2430	3280	280	192	127	125	364	160	87	104
Alkalinity ($CaCO_3$)	0	0	30	0	184	0	0	0	204	205	188	197	179	148	108	134
Conductivity (µmhos/cm @ 25°C)	2980	3470	950?	3340	635?	7540	6450	7350	417	360	356	364	446	336	205	263
TRACE METALS, mg/l																
Arsenic	<0.02	<0.02	0.03	0.21	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	0.016	<0.004	0.016	0.012	0.01	0.032	0.021	0.032	0.015	<0.004	0.008	0.003	0.057	0.010	0.003	<0.002
Manganese	2.14	1.28	1.40	1.82	0.184	4.94	4.96	7.76	0.062	0.050	0.052	0.036	0.118	0.020	0.020	0.016
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.029	0.008	0.36	0.022	0.031	0.066	0.018	0.048	0.076	0.027	0.118	0.036	0.057	0.016	0.024	0.012
RADIO-CHEMICAL DATA, pCi/l																
Gross Alpha Radiation	29.4	--	--	--	3.9	--	--	--	19.9	<1.7	--	<2.8	21.9	<3.1	--	<2.6
Radium 226	3.8	--	--	--	0.5	--	--	--	1.9	--	--	--	2.0	--	--	--

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*High value probably due to high suspended sediments and soil particles.
Locations shown in Figures 3.2-7 and 3.2-8

TABLE A3.2-2

GROUNDWATER QUALITY DATA
SUWANNEE RIVER PLANT
OCCIDENTAL SHALLOW POTABLE WELLS

Well Number	Mines Supervisor Trailer				Mines Administration Building		Beneficiation Plant					Chemical Plant				
	MST				MAB		MD-1			MD-2		CD-1			CD-2	
Depth of Collection Zone	160-240'				107-160'		?-115'			?-190'		?-315'			200-248'	
Date Sampled	3/1/76	1/18/78	2/29/78	4/18/78	3/1/76	4/18/78	6/70	3/1/76	4/18/78	3/1/76	4/18/78	6/70	3/1/76	4/16/78	3/1/76	4/18/78
Sample Number	*	8900	9089	9364	--	9363	--	*	9372	*	9371	--	*	9374	*	9375
Temperature °C	--	20	20.5	--	--	21	--	--	24	--	--	--	--	--	--	--
Color (APHA Units)	5	0	1	0	10	0	--	10	1	20	1	--	5	1	15	0
pH (Field)	--	6.7	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--
(Lab)	7.8	7.9	7.4	7.7	7.3	7.1	7.5	7.4	7.1	7.6	6.8	7.7	7.5	7.5	7.7	7.3
NUTRIENTS, mg/l																
Nitrogen-N																
Ammonium	--	0.19	<0.02	<0.02	--	<0.02	--	--	0.11	--	0.09	--	--	0.13	--	0.15
Nitrate	0.11	0.008	0.08	0.005	0.15	0.012	1	0.16	0.025	0.08	0.085	1	0.16	0.013	0.15	0.010
Organic Dissolved	--	<0.02	<0.02	<0.02	--	0.02	--	--	0.09	--	0.05	--	--	<0.02	--	0.22
Phosphates-P																
Ortho	--	0.198	0.120	0.267	--	0.186	--	--	6.00	--	6.00	--	--	0.116	--	0.148
Total Phosphorus	--	0.220	0.160	0.30	--	0.38	1.6	--	12.8	--	14.4	1.6	--	0.29	--	0.29
Dissolved Organic Carbon	--	5.0	7.0	2.5	--	7.0	--	--	5.5	--	7.0	--	--	6.0	--	4.5
MAJOR CONSTITUENTS, mg/l																
Iron	0.45	0.38	0.53	0.48	0.33	0.24	--	0.37	0.65	0.85	0.81	--	0.19	0.06	0.24	0.24
Calcium	52	39	22.2	21.7	87	91.8	51	64	31.2	59	29.3	52	56	29.3	53	25.1
Magnesium	3.9	15.9	15.6	15.5	3.2	9.9	29	16	21.6	16	19.3	26	18	20.8	17	21.6
Sodium	6.5	5.6	9.9	6.9	5.4	5.9	--	9.6	12.4	11	12.0	--	10	12.4	6.7	9.2
Potassium	0.88	0.56	0.80	0.48	1.0	0.69	--	0.98	0.84	0.90	0.72	--	1.2	0.96	0.93	0.60
Sulfate	13	2.2	6.7	<1.0	18	<1.0	3	34	35	52	34	38	55	45	24	23
Sulfides	--	0.36	0.08	0.09	--	0.04	--	--	<0.02	--	0.10	--	--	0.39	--	0.14
Chloride	11	4.5	4.1	5.0	11	6.0	12	15	10	20	11	15	20	11	9.9	9.0
Fluoride	0.88	0.86	0.82	0.73	0.37	0.33	0.66	0.64	0.60	0.68	1.7	0.45	0.38	0.37	0.54	0.51
Strontium	--	<0.15	<0.13	0.06	--	0.06	--	--	<0.05	--	<0.05	--	--	0.08	--	<0.05
Dissolved Solids	--	222	330	192	--	242	--	--	248	--	274	--	--	312	--	271
Total Solids	231	310	332	196	311	243	240	303	257	318	278	290	314	508	297	276
Hardness (Total)	148	163	120	118	232	270	248	224	167	214	153	236	220	159	203	152
Alkalinity ($CaCO_3$)	161	173	179	172	230	230	206	204	205	170	175	175	167	178	196	200
Conductivity (μmhos/cm @ 25°C)	--	329	320	294	--	381	--	--	435	--	392	--	--	417	--	402
TRACE METALS, mg/l																
Arsenic	--	<0.02	<0.02	<0.02	--	0.03	<0.02	--	<0.02	--	<0.02	<0.001	--	<0.02	--	<0.02
Chromium	--	<0.003	<0.004	<0.002	--	<0.002	0	--	<0.002	--	0.003	0	--	0.003	--	<0.002
Manganese	--	0.029	0.020	0.029	--	0.012	--	--	0.036	--	0.035	--	--	0.016	--	0.036
Mercury	--	<0.0002	<0.0002	<0.0002	--	<0.0002	--	--	<0.0002	--	<0.0002	--	--	<0.0002	--	<0.0002
Zinc	--	0.099	0.078	0.154	--	0.048	ND	--	0.009	--	0.18	--	--	0.009	--	0.005
RADIO-CHEMICAL DATA, pCi/l																
Gross Alpha Radiation	--	2.9	<1.5	<1.6	--	9.2	--	--	3.9	--	18.0	--	--	3.2	--	<2.3
Radium 226	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--

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*Thornton Laboratories; Tampa
All more recent data from Black, Crow & Eidsness; Gainesville
ND = None Detectable
Locations shown in Figure 3.2-7

TABLE A3.2-3

GROUNDWATER QUALITY DATA
SUWANNEE RIVER CHEMICAL PLANT
DEEP PRODUCTION WELLS

Well Number	C-1										C-2	C-3
Depth of Collection Zone	189-803'										202-700'	210-800'
Date Sampled	10/22/68	9/24/69	6/70	8/16/72	6/29/73	7/9/74	7/19/75	3/1/76	8/5/77	4/18/78	3/1/76	4/18/78
Sample Number	50815	--	--	--	--	--	--	*	--	9376	*	9361
Temperature °C	--	--	--	--	--	--	--	--	--	--	--	21
Color (APHA Units)	--	--	--	--	--	--	--	40	--	12	15	1
pH (Field)	--	--	--	--	--	--	--	--	--	--	--	--
(Lab)	--	7.6	7.6	7.4	7.8	7.4	7.2	8.1	7.2	7.1	7.6	6.9
NUTRIENTS, mg/l												
Nitrogen-N												
Ammonium	--	--	--	--	--	--	--	--	--	0.03	--	0.21
Nitrate	0.02	1.3	1	ND	ND	1	1	0.15	0.02	<0.005	0.21	0.007
Organic Dissolved	--	--	--	--	--	--	--	--	--	0.09	--	0.10
Phosphates-P												
Ortho	--	--	--	--	--	--	--	--	--	0.236	--	0.184
Total Phosphorus	0.2	ND	1.6	2.9	1.9	1.0	4.3	--	0.1	0.34	--	0.47
Dissolved Organic Carbon	--	--	--	--	--	--	--	--	--	11.5	--	11.0
MAJOR CONSTITUENTS, mg/l												
Iron	0.1	ND	--	0.4	0.28	1.5	1.4	0.20	0.11	0.37	0.94	0.72
Calcium	66	32	60	82	55.8	47.5	179	76	59	70.2	99	75.6
Magnesium	23	19	28	8.7	4.7	19.3	22.3	3.3	17	21.6	15	23.5
Sodium	1.6	13	--	11	11.9	10.4	10.4	11	10	14.3	18	16.6
Potassium	--	--	--	--	--	--	--	1.5	--	1.20	2.1	1.20
Sulfate	9.9	54	51	66.5	50	ND	78	59.0	42	58	145.0	85
Sulfides	--	--	--	--	--	--	--	0.16	--	0.56	0.47	1.28
Chloride	28	7.3	17	17	15	9	16	13	14	12	21	15
Fluoride	0.7	ND	0.44	ND	ND	0.5	0.9	0.42	0.37	0.44	0.42	0.41
Strontium	--	--	--	--	--	--	--	--	--	0.12	--	0.15
Dissolved Solids	--	--	--	--	--	--	--	--	--	313	--	411
Total Solids	--	--	320	--	--	--	--	314	--	318	447	420
Hardness (Total)	--	--	263	--	--	--	--	204	--	204	312	286
Alkalinity ($CaCO_3$)	--	--	187	--	--	--	--	178	--	196	186	178
Conductivity (µmhos/cm @ 25°C	--	--	--	--	--	--	--	--	--	453	--	560
TRACE METALS, mg/l												
Arsenic	--	--	<0.001	--	--	--	--	--	--	<0.02	--	<0.02
Chromium	--	--	ND	--	--	--	--	--	--	0.006	--	0.005
Manganese	--	--	--	--	--	--	--	--	--	0.02	--	0.034
Mercury	--	--	--	--	--	--	--	--	--	<0.0002	--	<0.0002
Zinc	--	--	ND	--	--	--	--	--	--	0.011	--	0.007
RADIO-CHEMICAL DATA, pCi/l												
Gross Alpha Radiation	--	--	--	--	--	--	--	--	--	<3.0	--	<3.1
Radium 226	--	--	--	--	--	--	--	--	--	--	--	--

* Thornton Laboratories; Tampa
More Recent Data From Black, Crow and Eidsness; Gainesville
ND= None Detectable
Locations shown in Figure 3.2-7

TABLE A3.2-3
(continued)

GROUNDWATER QUALITY DATA
SUWANNEE RIVER BENEFICIATION PLANT
DEEP PRODUCTION WELLS

Well Number	M-1											M-2		M-3
Depth of Collection Zone						180-1265'						204-700'		190-804'
Date Sampled	10/22/68	9/24/69	8/16/72	6/29/73	7/9/74	7/19/75	3/1/76	8/5/77	1/18/78	2/23/78	4/19/78	3/1/76	4/18/78	4/18/78
Sample Number	50812	--	--	--	--	--	*	--	8897	9088	9380	*	9373	9362
Temperature °C	--	--	--	--	--	--	--	--	22	21.6	--	--	22	20.5
Color (APHA Units)	--	--	--	--	--	--	30	--	35	40	55	30	65	110
pH (Field)	--	--	--	--	--	--	--	--	6.7	6.9	--	--	--	--
(Lab)	--	7.5	7.3	6.7	7.6	7.4	7.1	7.3	7.5	7.2	6.9	6.6?	7.1	6.9
NUTRIENTS, mg/l														
Nitrogen-N														
Ammonium	--	--	--	--	--	--	--	--	0.51	0.10	0.14	--	0.22	0.10
Nitrate	<0.01	1.0	ND	ND	1	ND	0.20	0.08	0.005	0.008	0.010	0.18	0.013	0.005
Organic Dissolved	--	--	--	--	--	--	--	--	0.46	0.05	<0.02	--	0.09	0.24
Phosphates-P														
Ortho	--	--	--	--	--	--	--	--	0.14	0.140	0.120	--	0.640	0.180
Total Phosphorus	2.2	ND	0.5	1.2	0.8	4.3	--	0.04	0.152	0.140	0.12	--	1.22	1.00
Dissolved Organic Carbon	--	--	--	--	--	--	--	--	12	11.0	9.0	--	10.5	10.5
MAJOR CONSTITUENTS, mg/l														
Iron	0.1	ND	0.4	0.21	2.0	0.7	0.54	0.12	0.23	0.29	0.49	0.36	0.09	0.47
Calcium	59	33	88	55.7	62.9	56.5	81	57	50	51.0	32.7	66	31.0	25.9
Magnesium	36	19	8.1	4.1	19.3	20	5.7	23	22.4	19.8	20.2	7.7	16.0	13.6
Sodium	6.9	13	10	6.67	8.9	8.9	12	11	10.8	27.4	13.8	8.5	10.6	11.1
Potassium	--	--	--	--	--	--	1.6	--	1.16	1.6	1.08	1.0	0.84	0.72
Sulfate	27	47	87.1	70	ND	136	66.0	57	56	60	58	36.0	42	30
Sulfides	--	--	--	--	--	--	0.52	--	2.1	1.64	0.43	1.0	0.74	1.04
Chloride	28	9.4	12	10	8	19	16	14	13	13	14	16	12	10
Fluoride	0.7	ND	ND	ND	0.6	0.8	0.41	0.35	0.84	0.31	0.35	0.33	0.36	0.28
Strontium	--	--	--	--	--	--	--	--	0.22	0.25	0.13	--		0.09
Dissolved Solids	--	--	--	--	--	--	--	--	374	313	262	--	250	164
Total Solids	--	--	--	--	--	--	335	--	452	314	274	243	256	166
Hardness (Total)	--	--	--	--	--	--	227	--	216	209	165	173	143	121
Alkalinity ($CaCO_3$)	--	--	--	--	--	--	174	--	170	169	167	143	144	125
Conductivity (μmhos/cm @ 25°C)	--	--	--	--	--	--	--	--	460	425	413	--	354	296
TRACE METALS, mg/l														
Arsenic	--	--	--	--	--	--	--	--	<0.02	<0.02	<0.02	--	<0.02	<0.02
Chromium	--	--	--	--	--	--	--	--	<0.003	<0.004	0.004	--	<0.002	<0.002
Manganese	--	--	--	--	--	--	--	--	0.026	0.027	0.041	--	0.027	0.031
Mercury	--	--	--	--	--	--	--	--	<0.0002	<0.0002	<0.0002	--	<0.0002	<0.0002
Zinc	--	--	--	--	--	--	--	--	0.121	0.023	0.019	--	0.007	<0.004
RADIO-CHEMICAL DATA, pCi/l														
Gross Alpha Radiation	--	--	--	--	--	--	--	--	3.4	<3.1	--	--	7.4	6.3
Radium 226	--	--	--	--	--	--	--	--	2.3	--	--	--	--	--

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*Thornton Laboratories; Tampa
More recent data from Black, Crow & Eidsness; Gainesville
ND = None Detectable
Locations shown in Figure 3.2-7

TABLE A3.2-4

WATER QUALITY DATA
SUWANNEE RIVER PLANT
PROCESS WATERS

Sample Location	Gypsum Stack			Cooling Ponds							
	GS-1			Pond Waters		CP-1			CP-2		
Date Sampled	1/16/78	2/24/78	4/18/78	8/20/77	12/8/77	1/17/78	2/28/78	4/18/78	1/16/78	2/24/78	4/18/78
Sample Number	8875	9074	9369	--	--	8874	9095	9370	8873	9073	9360
Temperature °C	25	12.5	22.7	--	--	13	19	26	11.5	12.5	23
Color (APHA Units)	110	110	110	--	--	110	110	120	90	100	100
pH (Field)	3.7	--	--	--	--	1.9	2.0	--	1.8	--	--
(Lab)	1.3	1.4	1.7	1.6	1.7	1.5	1.7	1.6	1.5	1.5	1.6
NUTRIENTS, mg/1											
Nitrogen-N											
Ammonium	141	198	205	--	--	13.4	177	299	326	328	326
Nitrate	0.193	0.32	<0.005	--	--	0.34	<0.005	<0.005	0.222	0.015	<0.005
Organic Dissolved	4.3	0.75	2.8	--	--	173	1.45	3.6	4.5	0.98	25.76
Phosphates-P											
Ortho	<0.008?	4900	4200	--	--	<0.008 ?	740	22.0	<0.008 ?	3850	200
Total Phosphorus	0.08?	5100	6200	4290	3960	0.044 ?	5100	4810	0.412 ?	4400	3380
Dissolved Organic Carbon	115	93.5	74.5	--	--	93	65.5	70.5	140	140	57.5
MAJOR CONSTITUENTS, mg/1											
Iron	95	158	220	263	204	88	30	120	172	132	110
Calcium	1150	303	550	500	77	1225	210	345	1425	298	366
Magnesium	157	150	155	44	76	156	155	164	138	130	144
Sodium	590	1090	897	1094	896	710	959	94	1150	1200	1380
Potassium	124	242	190	--	--	128	232	205	140	276	248
Sulfate	5700	4700	4340	5700	6200	5300	3800	4720	6000	5250	5540
Sulfides	0.41	0.49	0.13	--	--	0.25	0.17	0.13	0.30	0.36	0.27
Chloride	62	60	69	45	72	71	66	70	58	49	51
Fluoride	3200	4600	3850	6500	6600	4000	4750	7100	6500	6800	2200
Strontium	18	16.5	1.89	--	--	20	16.0	1.89	19	16.0	1.95
Dissolved Solids	28400	22300	28100	26250	25950	24700	24400	30300	24600	23300	26100
Total Solids	--	25300	28300	26285	26020	--	24400	30400	--	24200	26300
Hardness (Total)	3520	13860	2010	--	--	3710	1160	1540	4130	1280	1510
Alkalinity ($CaCO_3$)	0	0	0	--	--	0	0	0	0	0	0
Conductivity (umhos/cm @ 25°C)	23400	21600	21900	24000	--	22300	22000	23300	28400	25700	26100
TRACE METALS, mg/1											
Arsenic	0.40	0.32	0.33	--	--	0.34	0.37	0.38	0.44	0.40	0.50
Chromium	1.2	1.40	1.44	--	--	1.1	1.56	1.14	1.6	1.10	0.90
Manganese	6.4	7.80	9.2	--	7.88	4.44	5.04	5.9	7.28	5.40	5.05
Mercury	0.001	0.0007	<0.0002	--	--	0.0007	0.0005	0.0004	0.0006	0.0007	0.0002
Zinc	1.96	2.05	2.8	--	1.46	1.7	1.92	2.4	1.86	1.16	1.20
RADIO-CHEMICAL DATA, pCi/1											
Gross Alpha Radiation	--	--	--	--	--	--	--	--	--	--	--
Radium 226	26.2	--	--	--	--	24.8	--	--	23.8	--	--

Locations shown in Figure 3.2-7

TABLE A3.2-5

WATER QUALITY DATA
SUWANNEE RIVER PLANT
TREATED PROCESS AND NON-PROCESS WATERS

	Liming Ponds					Chemical Plant Retention Pond		Altman's Bay Lake Discharge	
Sample Location	Stage I LP-1		Stage II LP-2		Stage II Supernatant	RP-1		ABC-2	
Date Sampled	2/28/78	4/18/78	2/28/78	4/18/78	12/8/77	2/28/78	4/10/78	2/23/78	4/18/78
Sample Number	9093	9367	9094	9368	--	9092	9365	9091	9366
Temperature °C	13.3	26	12.8	26	--	13.8	26.5	12	26
Color (APHA Units)	55	50	17	28	--	5	4	12	25
pH (Field)	2.8	--	5.6	--	--	6.4	--	6.6	--
(Lab)	2.9	3.2	6.1	6.2	9.0	7.1	7.9	6.6	7.1
NUTRIENTS, mg/l									
Nitrogen-N									
Ammonium	115	115	91	86.8	--	13.0	37.8	17.0	11.4
Nitrate	0.275	0.272	0.181	0.081	--	1.20	0.570	1.12	1.07
Organic Dissolved	2.15	--	1.82	1.10	--	0.44	0.50	0.74	0.85
Phosphates-P									
Ortho	160	22.6	40.0	20.0	--	110	6.40	101	18.0
Total Phosphorus	220	2090	60.0	96.0	1-13	112	18.0	111	19.2
Dissolved Organic Carbon	40.5	35.5	20.5	15.5	--	11.5	3.5	12.5	4.9
MAJOR CONSTITUENTS, mg/l									
Iron	17	4.0	0.46	1.4	0.10	0.49	0.46	0.62	0.43
Calcium	570	1120	153	98.7	375	76.5	21.7	31.0	28.0
Magnesium	122	148	41.6	27.7	22	18.2	17.4	18.1	16.2
Sodium	794	707	728	552	900	82.7	62.1	86.2	36.2
Potassium	138	91	86.4	72.8	--	6.4	4.18	7.1	3.7
Sulfate	2210	2580	1200	1870	2709	220	31	164	187
Sulfides	0.10	2.60	13.8	6.72	--	0.21	0.27	0.26	2.45
Chloride	41	42	38	42	75	16	17	14	13
Fluoride	645	410	44	20.0	12-20	11.8	6.90	8.8	4.10
Strontium	6.0	0.87	0.75	0.12	--	0.20	0.06	<0.13	0.06
Dissolved Solids	12600	13800	3550	3130	--	564	423	479	451
Total Solids	12600	13900	3570	3200	--	574	430	507	482
Hardness (Total)	1930	3410	554	361	--	226	126	152	135
Alkalinity ($CaCO_3$)	0	0	99	49	--	90	136	77	56
Conductivity (umhos/cm @ 25°C)	7540	7600	3780	3180	--	762	813	640	571
TRACE METALS, mg/l									
Arsenic	0.11	0.19	0.03	0.02	--	<0.02	<0.02	<0.02	<0.02
Chromium	0.96	0.29	0.010	0.12	--	0.008	0.005	<0.04	0.004
Manganese	5.72	6.14	0.372	0.132	0.03	0.047	0.014	0.082	0.104
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	--	<0.0002	<0.0002	<0.002	<0.002
Zinc	1.16	1.5	0.016	0.012	<0.10	0.011	0.006	0.007	0.012
RADIO-CHEMICAL DATA, pCi/l									
Gross Alpha Radiation	--	--	--	43.9	--	--	10.7	1.8	4.3
Radium 226	4.3	--	<0.2	--	--	4.9	--	<0.2	--

Locations shown in Figure 3.2-7

LIST OF REFERENCES
(Section 3.2)

Wissa, A. E. Z. (1977), "Gypsum Stacking Technology," 1977 Annual Meeting, Central Florida and Peninsular Florida Sections, American Institute of Chemical Engineers, Clearwater, Florida, May 1977

3.3 ENVIRONMENTAL EFFECTS OF THE PROPOSED CHEMICAL COMPLEX ON BIOLOGY AND ECOLOGY

3.3.1 BENEFICIAL AND DETRIMENTAL IMPACTS

3.3.1.1 Site Construction Impacts

3.3.1.1.1 Vegetation Impacts -- The proposed chemical plant and associated facilities are located adjacent to the Swift Creek Beneficiation Complex and U.S. Highway 41 (Figure 2.7-9). Swift Creek Swamp, a hardwood dominated wetland, lies immediately north of the beneficiation complex and proposed chemical complex (Figure 2.7-6). Portions of the site to be used for gypsum storage and cooling ponds (Figure 3.3-1) have been or will be selectively mined prior to construction activities.

Presently, most of the site exists as flatwood clear cuts, natural pine flatwoods, or as young pine plantations with small cypressheads and several mixed hardwood swamps are scattered through the area (Figure 3.3-1). A portion of the proposed gypsum storage area has already been mined and is a young spoil pile and open lake system. An area immediately west of the mined area has been site prepared for mining through vegetation removal and dewatering activities.

Clearing activities for the chemical plant site, temporary cooling pond gypsum stack and associated facilities will result in a loss up to 650 acres of flatwoods/cypresshead vegetation. The loss of these vegetation communities is of minor importance when their degraded nature and their abundance locally and within the five-mile project area (Figure 2.7-6) are considered.

3.3.2 IMPACT EVALUATION

3.3.2.1 Biology and Ecology

3.3.2.1.1 Aquatic Communities of the Area -- The proposed facility will regularly discharge nonprocess water and rainfall runoff and will infrequently discharge treated process water into Swift Creek. The discharge pattern and quality will be comparable to that of the existing Suwannee River Chemical Complex (Section 3.2.6) and is expected to remain below water quality guidelines and legal limitations.

Since the water quality of Swift Creek and the Suwannee River will not be significantly altered, no significant change in the composition or vitality of their aquatic communities should occur. Any change in system conditions can be expected to cause some change in community composition, but the magnitude of expected changes in the Swift Creek/Suwannee River system are not sufficient to warrant concern over the health of its existing communities.

The aquatic communities of Swift Creek are apparently substrate and light limited (Section 2.7.4.1) and would be sensitive to any changes in the stream bed or surrounding forest canopy. A major change in the flow of Swift Creek could change aquatic community distribution and composition by altering the transport and deposition of stream sediments and by changing the flood characteristics which control vegetation within the surrounding floodplain. The proposed facility will increase the base flow of Swift Creek by an average of about 2.0 cfs, which represents an increase of about 3 percent over present conditions (Section 3.2.4.1).

Site surface runoff, erosion and subsequent deposition during construction could be detrimental to the vegetation of Swift Creek Swamp due to its close proximity to the proposed site and because natural drainage is toward the swamp. However, runoff from the cleared site will be collected by perimeter ditches (Section 3.2.3.1), mitigating any potential sedimentation impacts to the vegetation of Swift Creek Swamp.

3.3.2.1.2 Loss of Prime Agricultural Land -- There is no prime agricultural land nor agricultural development within the area of the proposed chemical complex (Section 2.11.4). Consequently, plant construction will have no impact on the agricultural productivity of the area.

3.3.2.1.3 Wildlife Habitat Loss -- A minimum amount of wildlife habitat exists on the site of the proposed chemical complex. The habitats present are highly modified by clear-cutting and mining operations, and the area supports a low species diversity. The bird species found in the area are characteristic of fields and hedgerows. Meadowlarks, sparrows, and Killdeer are common as are wintering raptors: the Kestrel, Marsh Hawk and Red-tailed Hawk. These modified communities offer relatively poor wildlife habitats with little cover for small mammals. Plant construction will remove large areas of this habitat but other adjacent and nearby habitats will be maintained, which will support similar species to those found in the area. The fields around the present Swift Creek facility and the Suwannee River plant are similar to the proposed plant site in species composition.

This should not greatly alter stream bed movement nor significantly increase flooding along Swift Creek (Section 3.2.4.3). In addition, the surficial aquifer drained by Swift Creek will not be affected by the proposed facility (Section 3.2.5.1), so possible indirect effects on the flow of Swift Creek by local water table drawdown are not expected to occur. In these regards, the aquatic communities along Swift Creek should not be noticeably affected by the proposed plant.

3.3.2.1.4 Terrestrial Communities of the Area -- Impacts associated with the operation of the proposed chemical complex on terrestrial biota are limited primarily to air emissions and water discharges. Parameters of interest are fluoride and sulfur dioxide. Terrestrial system water discharge impacts would be a result of an increased baseflow in Swift Creek. Groundwater pumpage from the facility will not affect the surficial aquifer (Section 3.2.5.1), so possible effects from local water table drawdown are not expected to occur.

3.3.2.1.5 Air Emission Impacts to Vegetation --

Fluoride -- Silicon tetrafluoride is the chief gaseous pollutant released to the atmosphere in many chemical manufacturing steps in the phosphate industry (National Academy of Sciences, 1971). In the manufacture of superphosphate fertilizer, ground phosphate rock is treated with sulfuric acid, and both hydrofluoric acid and silicon tetrafluoride are formed. Both of these compounds are also formed in the production of wet-process phosphoric acid and triple superphosphate fertilizer. In most chemical plants today, these gases are passed through scrubbers, and most of the silicon tetrafluoride is removed through reactions to form aqueous fluorosilicic acid.

In the manufacture of wet process phosphoric acid, waste liquors and slurries are produced that contain gypsum, radium, potassium fluorosilicates, hydrofluoric acid, and fluorosilicic acid (National Academy of Sciences, 1971). Large settling ponds are used for these waste accumulations. Volatile fluorides vaporizing from these ponds are not controlled and many constitute up to 90 percent of the total fluoride emissions to the atmosphere (National Academy of Sciences, 1971).

Plants are receptors of fluoride from three sources: soil, water and air. The phytotoxicity of fluoride from the soil and water is relatively unimportant (National Academy of Sciences, 1971). Phytotoxic responses to fluoride is usually attributable to airborne forms such as hydrogen fluoride and silicon tetrafluoride.

Once fluoride has entered a plant, it moves in the transpirational stream and generally accumulates in the foliar tissues in leaf margins and apices. Fluoride accumulated in these regions does not move to other leaves of the plant (National Academy of Sciences, 1971).

The nature of fluoride-induced effects in plants varies. At the cellular level, effects on enzyme kinetics, metabolic pathways, modification of cellular organelles, death and disruption of cells have been observed (National Academy of Sciences, 1971). Decreased assimilation and altered respiration, altered growth and development, chlorotic and necrotic lesions, and death and abscission have been reported at the tissue level of organization (National Academy of Sciences, 1971). Effects at the cellular and tissue level result in modified growth, reduced reproduction, and possibly death of the entire plant.

A survey conducted by Brandt (1977; 1978) revealed minor fluoride injury to several young pines planted along the southern and southwestern dikes forming the cooling pond at the Suwannee River Chemical Plant. Observations made during the present study showed that Baccharis halmifolia, Myrica cerifera and grasses growing along these portions of the dike system had necrotic and chlorotic lesions. On the wax-myrtle plants, most of the stems facing the cooling ponds were killed. On the Baccharis plants, which are more abundant on the baffle dikes located within the cooling pond, the necrotic and chlorotic lesions were more prevalent and were observed on all stems. No fluoride effects were noted in plants that were beyond the pond dikes.

The types of vegetation and their distribution around the proposed cooling ponds at the SCCC are similar to those around the Suwannee operations. Therefore, one could expect that similar limited fluoride injury would occur. Farm crops are not grown in the immediate area around the proposed Swift Creek Chemical Complex; therefore, the economic impact of fluoride injury would be negligible.

Future mining around the proposed chemical complex will eliminate commercial forests from the area during the life of the project. Therefore, there will be no economic impact to forest interests resulting from fluoride emissions.

Sulfur Dioxide -- In the production of wet-process phosphoric acid and triple superphosphate fertilizer, large quantities of sulfuric acid are used. The sulfuric acid used by Occidental is produced on-site. During production some sulfur dioxide is given off as a by-product along with some sulfuric acid mist. The emission of these compounds is regulated by state and federal emission standards. At the Suwannee River Chemical Complex, there are two single absorption sulfuric acid plants and two double absorption plants.

Sulfur dioxide enters vegetation through the stomata and causes various metabolic and structural changes (Mudd and Kozlowski, 1975). Usually, visible injury is initially observed as interveinal chlorosis in young but fully expanded leaves. Mature leaves may later show sulfur dioxide injury.

It is generally thought that sulfur dioxide damage occurs after a threshold concentration in the plant is reached (Mudd and Kozlowski, 1975). Below a certain concentration, no damage occurs, presumably because the plant can metabolize the sulfur dioxide to nontoxic compounds. Above a certain concentration, damage occurs because the toxic compounds accumulate.

A survey conducted by Brandt (1977; 1978) in the vicinity of the Suwannee River Chemical Complex indicated that none of the vegetation surrounding the complex showed symptoms indicative of chronic sulfur dioxide injury. However, an area immediately west of the chemical complex showed evidence of a moderately severe burn from sulfuric acid mist. This area was west of S.R. 137 and covered an area approximately 1.2 miles in a north-south direction and 0.4 miles in an east-west direction. Major injury occurred within an approximately eight year old slash pine plantation. Symptoms were observed on pines and on evergreen oak (species unidentified). It is not known whether symptoms appear on deciduous trees because the survey was conducted in November after leaf fall.

The types of vegetation around the Swift Creek site are similar to those around the Suwannee River site. The effects from chronic sulfur dioxide exposure will not occur since air quality modeling shows that secondary air quality standards - those developed to protect vegetation with a margin of safety - will be met. Since the sulfuric acid plants proposed for the Swift Creek site are double absorption plants - those applying Best Available Control Technology - the emission of sulfuric acid mist (and SO_2) will be better controlled. Therefore, even under start-up and up-set conditions, acute acid mist and sulfur dioxide burns will not be expected.

Faunal Components -- The general impact of the proposed new chemical plant on the 5-mile study area faunal components will be minimal. Site specific detrimental impacts will be the loss of 650 acres from the construction of the proposed chemical plant site, temporary cooling pond, gypsum stack and associated facilities (Section 3.3.1). Generally the area is a highly disturbed pine flatwoods with interspersed cypress domes. The habitat quality within a five-mile radius of the site is degraded from mining activities, site preparation and forestry practices (clear-cutting). The impact of the loss of 650 acres of habitat from the proposed plant site is considered minimal, due to the disturbed habitat quality and the abundance of other habitat types within the vicinity (Section 3.3.1). Adjacent habitats will be impacted by the increase in human activities in the area. Those species whose tolerance of human interference is minimal will be the most severely affected. The extent of this impact is presumed to be minimal due to the human disturbance factors associated with present activities at the Swift Creek site and nearby Suwannee River Chemical Complex and mine.

Direct impacts on faunal components by air pollutants (sulfur dioxide and fluoride emissions) is not known. Existing studies deal primarily with domestic species (National Academy of Sciences, 1971).

Indirect effects may be realized through degradation and destruction of vegetation. Air emission effects in vegetation have been observed around the SRCC (Section 2.2.2.3.2). The adverse air emissions impact on vegetation degrades habitat in the immediate plant vicinity for the faunal components by degradation or destruction of potential food resources, escape cover, and possibly nesting sites. Since emission standards will be met, significant injury to habitat (vegetation) from sulfur dioxide should not occur. Localized fluoride impacts from cooling ponds will occur, as reported at the Suwannee River Chemical Complex cooling pond (Brandt, 1977; 1978).

The discharge from the proposed Swift Creek Chemical plant will increase the average flow of Swift Creek by approximately 3 percent (Section 3.2.4.1). This should not result in any significant loss or degradation of terrestrial habitat along Swift Creek since the water level is not expected to increase more than 0.05 feet at any point during periods of intermediate flow when chronic flood stress could occur (Section 3.2.4.3).

3.3.2.2 Swift Creek Watershed

3.3.2.2.1 Aquatic Communities -- Aquatic communities in Swift Creek will be impacted little, if at all by discharges from the SCCC. Water discharged into Swift Creek will meet all water quality guidelines and required limitations and therefore should not result in a detrimental impact on the Swift Creek aquatic system. Macroinvertebrate, periphyton and fish data support the conclusion that substrate is more limiting to the community distribution and composition along Swift Creek than is water quality. The expected 3 percent increase in the average flow of Swift Creek (Section 3.2.4.1) should not bring about major substrate changes and should not, therefore, significantly alter the present distribution and composition of aquatic communities in Swift Creek or the Suwannee River.

3.3.2.2.2 Streamside Terrestrial Communities -- Operation of the proposed facility will increase the water level in Swift Creek by no more than 0.05 feet above its present levels during periods of intermediate flow (Section 3.2.4.3). Since the structural character of streamside vegetational communities is determined by the frequency, depth and duration of inundation periods, and the stream banks along Swift Creek are deeply incised into the surrounding topography, no vegetational changes will result from the added discharge into the stream.

3.3.2.2.3 Faunal Components -- Impacts to the terrestrial fauna of the five-mile study area have been discussed earlier in this section. These same impacts will apply to the terrestrial fauna of the Swift Creek watershed. The impacts which are specifically addressed are loss of terrestrial habitat due to the increase in discharge and impacts which may result from the water quality of discharge waters in Swift Creek. Loss or degradation of terrestrial habitat is not expected to occur from the 3 percent increase in the average flow of Swift Creek and the 0.05 foot increase in intermediate flow levels (Sections 3.2.4.1 and 3.2.4.3). The impact on faunal components in Swift Creek proper should minimal since the proposed new discharge will meet all water quality guidelines and legal limitations.

3.3.2.3 Other Important Biology and Ecology Impacts

3.3.2.3.1 Unique Natural Communities -- The southern mixed hardwood forests which occur near the confluence of Swift Creek and the Suwannee River grow atop the most steeply-incised section of the Swift Creek channel (Section 2.7.5.1). In view of the distance of this unique community from the proposed plant site and the low water level changes expected as a result of its operation (Section 3.2.4.3), the SCCC will have no impact on these communities.

3.3.2.3.2 Environmentally Sensitive Areas -- Areas within the five-mile project radius or the Swift Creek watershed considered environmentally sensitive include the Suwannee River, Bee Haven Bay and the southern mixed hardwoods communities along te downstream portion of Swift Creek (Section 2.11). Discharge from the proposed facility will not greatly alter the chemical composition or flow characteristics of Swift Creek (Sections 3.2.6 and 3.2.4.1) and no degradation to the Suwannee River or the southern mixed hardwoods along Swift Creek is anticipated. Bee Haven Bay is isolated from discharges into Swift Creek and is not expected to be adversely affected by air emissions from the plant or its support facilities (Section 3.1). Therefore, no impacts to environmentally sensitive areas are anticipated.

3.3.2.3.3 Endangered, Threatened and Rare Plants and Animals -- Seventy species of endangered, threatened, and rare plants and animals are suspected to occur within the study area (Section 2.7.5.2). The basis for concern for many of these species is a function of habitat loss and the degradation usually resulting from human interference or influence which results in population declines. The present land use policy within the study area (agriculture, mining and silviculture) had depleted or eliminated habitat for many of the endangered, threatened or rare species. Species such as the Red-cockaded Woodpecker, Florida Panther and White-breasted Nuthatch, have been extirpated from the area due to alteration, degradation and loss of habitat. Other species, such as the Herons, Bald Eagle and Peregrine Falcon have benefited from these alternations, particularly newly created aquatic and open-field habitats.

The proposed chemical plant will have little impact on listed species of the area. The greatest impact realized will be to those listed species associated with cypress dome habitats. Such species include the Many-lined salamander, Striped newt and Carpenter frog. However, the presence of these particular species in the study area is speculative and these areas are of low quality due to intensive local land use.

The impact of the discharge system and air emission on fauna and flora have been discussed previously and apply as well to endangered, threatened and rare species.

3.3.2.3.4 Migratory Wildlife and Habitat -- Because of the highly modified condition of the plant site, a limited amount of habitat is available for migratory wildlife. Migrant birds that are common in farm fields in the area, such as the Savannah Sparrow, Vesper Sparrow, Meadowlark, Palm Warbler and Killdeer are also found on the proposed plant site. The Swift Creek Chemical Complex will remove portions of this marginal habitat. Plant construction will have no effect on migrant populations.

3.3.2.3.5 Wildlife Benefits of the Area to Man -- Up to 650 acres of developing flatwoods or plantation and cypressheads to be committed to site facilities are not a significant source of wildlife related recreation. It is also unlikely that the recreational potential of the site would improve were the facility not constructed, due to the locally intensive timber management and the expansion of ongoing mining. Loss of these habitats would not, therefore, adversely impact the recreational capabilities of the area to any significant degree.

3.3.2.4 Long-term Vs. Short-term Impacts

3.3.2.4.1 Aquatic Impacts -- No impacts to aquatic organisms are anticipated due to discharges from the proposed facility. Comparison of long and short-term impacts is therefore unwarranted.

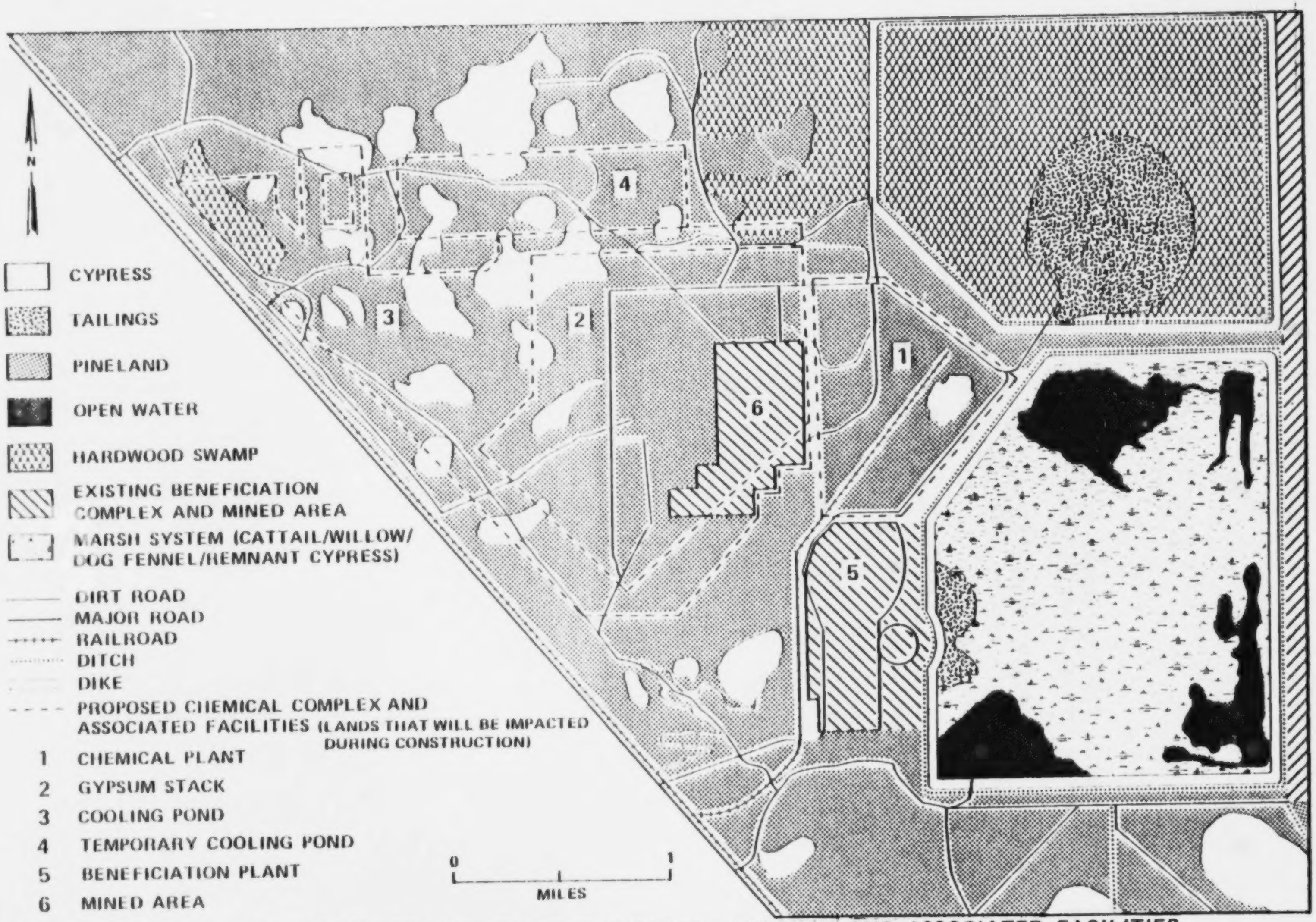
3.3.2.4.2 Terrestrial Impacts -- Construction of the proposed chemical complex and associated cooling ponds and gypsum storage areas will permanently remove up to 650 acres of low quality pineland/ cypress vegetation and associated wildlife (Section 3.3.1). These are the only long-term impacts from Occidental's proposed expansion.

Short-term impacts to the terrestrial biota could result from air pollution injury to local vegetation during the operational phase of the project. However, the emission rates from the facility (Section 3.1) are not expected to reach levels which could cause any extensive effects in the surrounding biota.

3.3.2.5 Reversibility

3.3.2.5.1 Aquatic Impacts -- There are no anticipated impacts to the aquatic biota. Therefore, a discussion of any reversibility is unwarranted.

3.3.2.5.2 Terrestrial Impacts -- As discussed in the previous section, short-term impacts to terrestrial biota is limited to minor vegetation injury from sulfur dioxide, acid mist and fluorides. These impacts are reversible at the end of the life of the project when air emissions stop. Long-term impacts to the terrestrial biota occur through the construction of the chemical plant and associated facilities. These impacts are to a large extent irreversible because of the deposition of various chemicals into the cooling ponds and gypsum storage areas. Such areas do not support the establishment of plant communities.


N
CYPRESS
TAILINGS
PINELAND
OPEN WATER
HARDWOOD SWAMP
EXISTING BENEFICIATION COMPLEX AND MINED AREA
MARSH SYSTEM (CATTAIL/WILLOW/DOG FENNEL/REMNANT CYPRESS)
DIRT ROAD
MAJOR ROAD
RAILROAD
DITCH
DIKE
PROPOSED CHEMICAL COMPLEX AND ASSOCIATED FACILITIES (LANDS THAT WILL BE IMPACTED DURING CONSTRUCTION)
1 CHEMICAL PLANT
2 GYPSUM STACK
3 COOLING POND
4 TEMPORARY COOLING POND
5 BENEFICIATION PLANT
6 MINED AREA
0
1
MILES
1
2
3
4
5
6

VEGETATION MAP OF THE PROPOSED SWIFT CREEK CHEMICAL COMPLEX AND ASSOCIATED FACILITIES

FIGURE 3.3-1

LIST OF REFERENCES
(Section 3.3)

Brandt, C.F. (1977), Report filed with Occidental Chemical Company, White Springs, Florida, Florida. 3 pp.

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Mudd, J.B. and T.T. Kozlowski (Eds.) (1975), "Responses of Plants to Air Pollution." Academic Press, Inc. New York. 383 pp.

National Academy of Sciences (1971), "Fluorides." Committee Biol. Effects Atmosph. Pollut., Div. Med. Sciences, Nat. Res. Coun., Washington, D.C. 295 pp.

3.4 SOCIOECONOMIC EFFECTS OF PROPOSED NEW SOURCE

3.4.1 OCCIDENTAL'S LABOR FORCE AND PAYROLL REQUIREMENTS

Occidental's own labor force requirements for their existing facilities are reflected in Table 3.4-1. It is anticipated that employment in 1978 will average about 1200 employees. By 1979, with the completion of the Phase I expansion, employment should be up to about 1350. Finally, it is anticipated that upon completion of the Phase II expansion (projected for 1980), employment will be about 1700. It is anticipated that Occidental's employment will remain at about the 1700 level throughout the duration of the Russian agreement, depending, of course, on the domestic and world supply and demand situation for phosphate.

A detailed discussion of the direct, indirect, and induced impact of the expansion program on employment and labor force in the immediate impact area (Columbia, Hamilton, and Suwannee Counties) is presented herein.

Occidental's payroll for the past several years is presented in Table 3.4-2. Also included in this table is the expected payroll for 1978, 1979, and 1980. The dollar amounts used here are in current dollar values for the years involved rather than in dollars of constant purchasing power.

3.4.2 SOCIOECONOMIC IMPACTS ON FLORIDA AND THE THREE-COUNTY IMPACT AREA

3.4.2.1 Introduction

This section is concerned with the socioeconomic impacts of Occidental Chemical Company within the state of Florida and within the three-county local impact area. Attention here is focused first on the role that Occidental played in the local economy as of 1976, the last year for which complete data have been made available to us. Next, attention is placed on the additional impacts that will result from the expansions which are planned for 1979 (Phase I) and 1980 (Phase II). It should be noted that it is Phase II for which an EPA water permit is currently being sought so that the impact of that expansion is what is most relevant for present purposes. However, in order to establish a base of comparison, it is necessary to first establish the pre-expansion impact that the company's operations have on the socioeconomic life of Florida and the three-county impact area.

Occidental's impacts on several important socioeconomic variables have been evaluated including: (1) income to people, (2) employment, (3) population, (4) housing requirements, (5) school enrollments, (6) demand for governmental services, (7) tax revenues, (8) and land use. This has been done by first estimating Occidental's direct, indirect, and induced impacts upon incomes to people and employment. The impacts on population, housing, and other variables have been derived from these first two. The following section takes up a detailed discussion of the methodology used in deriving the estimates of income and employment impacts. Later sections present the resulting measures of these impacts as well as impacts on the other variables and the way they are derived.

3.4.2.2 Methodology for Measurement of Income and Employment Impacts

The basic approach taken to estimate the impact of Occidental's operations in North Florida is to apply input-output (I-O) multipliers on an industry-by-industry basis to Occidental's expenditures within Florida. In this way it is possible to estimate the income to people in Florida which results from Occidental's own payroll, from their purchases of electricity and gas, payment of operating expenses and supplies, construction, payment of taxes, and so forth. It is also possible to estimate the number of Floridians who could be expected to be employed as a result of these expenditures.

The use of this methodology makes it possible to determine three levels of impact of such expenditures; the direct impact, the indirect impact, and the induced impact. The direct income impact includes Occidental's own payroll and that part of the payrolls and earnings of proprietors of Florida firms which is made possible by Occidental's purchases from them, as well as that part of state and local governmental payrolls which are made possible by Occidental's payment of state and local taxes.

The indirect impact of Occidental's expenditures on the income of Floridians includes the payrolls and proprietors' income which results when Occidental's suppliers make purchases from other Florida firms in order to supply Occidental's needs, as well as the payrolls and proprietor's incomes of the Florida firms which supply those firms' needs, and so forth. Stated another way, a part of the money paid by Occidental to its suppliers is used to purchase goods from other firms. These firms, in turn, use a part of this to meet their payrolls and use a part of the rest to make purchases from still other firms, and these, in turn, use a part of their receipts to meet their payrolls and a part to make purchases from still other firms, and so forth until perhaps every firm in Florida is affected to some degree by Occidental's original expenditures. Of course, the effect on income at each succeeding round of expenditures becomes smaller and smaller after each round.

The induced impact of Occidental's expenditures on the incomes of Floridians results from the expenditure by Occidental's employees of their salaries and wages for food, clothing, and so forth, within Florida, as well as the expenditures by the employees of Occidental's suppliers of that part of their income which results from Occidental's original purchases, the expenditure by the employees of the suppliers of Occidental's suppliers, and so forth, in successive rounds. Thus, the indirect impact results from inter-industry trading by Florida firms in an effort to meet Occidental's needs. The induced impact results from the consumer expenditures of Occidental's employees, the employees of Occidental's suppliers, their suppliers, and so forth, as well as the income earned and spent by the grocery clerks, the department store clerks, and so forth, where all these employees spend their incomes.

It is easy to see then that the total impact of Occidental's operations on income may well be several times larger than their direct payroll. Similarly, the total employment which ultimately results from

Occidental's operations may be several times larger than their direct employment at their mines and plants.

Emphasis thus far has been on income impacts. Basically the employment impacts of Occidental Chemical Company are measured in about the same way that the income impacts are measured. The income impact as discussed above is needed, however, in the measurement of the employment impact. Population impacts, impacts on housing needs, school enrollment, increased public service needs, taxes, and land use are then all derived from the measured impacts on income and employment.

To make clearer the methodology used in measuring the impacts, it is perhaps worthwile to discuss briefly the concept of input-output multipliers. The basic concept from which multipliers are developed is that of an input-output table. Such a table for a state can be depicted as in Figure 3.4-1.

Figure 3.4-1, in effect, depicts the flow of goods and services from each industry in the economy to each other industry in the economy as well as sales to households, governments, and exports to other states and other countries. For example, reading across row 1 of the table, the value of X_{11} is the amount of industry number 1 sales to other firms in the same industry. X_{12} is the amount that industry 1 sells to industry 2, and so forth. Similarly, f_{11} is the amount that industry 1 sells to "final demand" sector 1, f_{12} is the amount sold to final demand sector 2, and so forth. The final demand sectors usually include sales to households, sales to governments, exports to other states and to other countries, and so forth. X_1 is the total value of output of industry 1, X_2 is the value of output of industry 2, and so forth.

Looking at Figure 3.4-1 another way (down the columns), a different view develops. Looking at column 1, for example, X_{11} represents the purchases of industry 1 from other firms in the same industry, X_{21} represents purchases of industry 1 from firms in industry 2, and so forth. At the bottom of the table, h_1 represents purchases by industry 1 from households (primarily payment of salaries and wages and other forms of household income for participation in operation of the enterprise). I_1 represents imports of goods and services from other states and countries as inputs to the product of the industry. O_1 represents payment of taxes and other such transfers. X_1, finally represents the total value of inputs into the production of the product of industry 1. Note that it is assumed that the total value of inputs is the same as the total value of outputs. Thus, an input-output table as shown above reflects the total flow of transactions within the economy of a state and its interaction with the rest of the world.

In order to develop the concept of an input-output multiplier, define

$$a_{ij} = X_{ij}/X_j, \quad \text{for } i, j=1, \ldots, n \qquad (1)$$

to be the proportion of the total value of the product industry j which represents purchases or inputs from industry i. Also, define

$$a_{n+1,j} = h_j/X_j, \quad \text{for } j=1, \ldots, n+1 \tag{2}$$

to be the proportion of the total product of industry j which represents the value of inputs from households (e.g., wages, salaries, and other income payments as a proportion of total value of product). Then, the first n rows of Figure 3.4-1 can be expressed in matrix equation form as follows:

$$AX + F = X \tag{3}$$

Here, A is an n x n matrix whose elements are a_{ij} as defined in equation (2), F is the matrix of the values f_{ij} in the final demand sector of Figure 3.4-1 and X is the vector whose elements X_i are the total outputs and total inputs shown in the last column and row of Figure 3.4-1. From equation (3) it can be seen that

$$X - AX = F \tag{4}$$

or

$$(I - A)X = F \tag{5}$$

It can also be shown that the vector X can be stated as a multiple of F, as follows:

$$X = (I - A)^{-1} F \tag{6}$$

Here, $(I - A)^{-1}$ is called the Leontief inverse of the input-output model and may be denoted as

$$M = (I - A)^{-1} \tag{7}$$

The elements of M, denoted as M_{ij}, represent the direct and indirect impact on industry i of a unit increase of the demand for (and output of) industry j. Thus, the vector μ can be defined as:

$$\mu = M \cdot U \qquad (8)$$

where U is a column vector made up only of ones. A given element of $\mu(\mu j)$ can also be stated as

$$\mu j = \sum_{i=1}^{n} M_{ij} \qquad (9)$$

This quantity represents the direct and indirect impact on the total product of the economy as a result of a unit increase in the demand for (and output of) industry j; this is the direct and indirect output multiplier for industry j.

If, for example, $\mu_1 = 1.85$, this means that a million dollar increase in the demand for (and output of) industry number 1 in the I - O table will result in a direct and indirect output of $1.85 million. Note that $(\mu_j - 1)$ is the indirect effect. That is, the $1 million above represents the direct effect of this expenditure and the $1.85 million represents the indirect effect only.

Now, if equation (3) above is modified by adding row n+1 and column n+1 from Figure 3.4-1 to the matrices in question, the result will be

$$A^*X^* + F^* = X^* \qquad (10)$$

Equation (10) is the same as equation (3), except that the household row and column (n+1) have been added to the matrix A as if the household sector was another industrial sector. Also, the $(n+1)^{th}$ element has been added to X and F to result in X* and F*.

Following through the same reasoning as reflected in equations (3) through (9), the total (direct, indirect, and induced) output multipliers are given by:

$$\mu_j^* = \sum_{i=1}^{n+1} M^*_{ij} \tag{11}$$

where M^*_{ij} is the ij^{th} element of:

$$M^* = (I - A^*)^{-1} \tag{12}$$

Given equations (9) and (11), the direct, indirect, and induced impacts on total output of any given industry j can be determined as follows:

Direct Multiplier = 1

Indirect Multiplier = $(\mu_j - 1)$

Induced Multiplier = $(\mu^*_j - \mu_j)$

Total Multiplier = μ^*_j

3.4.2.2.1 The Income Multiplier

The I-O multipliers discussed above measure the increase in the output of all industries for a given unit increase in the product of industry j. It has been shown by Burford[1] that the increase in income from all industries resulting from a unit increase in the product of industry j is given approximately as follows:

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[1] Roger L. Burford, "Regional Input-Output Multipliers Without a Full Input-Output Table," Annals of Regional Science, November 1977.

Direct Income Multiplier = $a_{n+1}, j \cdot 1$

Indirect Income Multiplier = $\bar{a}_{n+1} \cdot (\mu_j - 1)$

Induced Income Multiplier = $\bar{a}_{n+1} \cdot (\mu^*_j - \mu_j)$

Total Income Multiplier = $a_{n+1}, j + \bar{a}_{n+1} (\mu^*_j - 1)$

As used above, a_{n+1}, j represents the proportion of the value of the product of industry j which is paid to households as salaries and wages and other forms of income and $\bar{a}_{n+1}$ is the average proportion of the value of output paid to households in all industry in the state.

In the same paper and others, Burford has shown that the direct and indirect output multiplier shown in equation (9) can be determined approximately by:

$$\mu_j = 1 + \frac{w_j}{1 - \bar{w}} \qquad (13)$$

where w_j is simply the column sum of the elements a_{ij} of column j of the matrix A already discussed. That is,

$$w_j = \sum_{i=1}^{n} a_{ij} \qquad (14)$$

and $\bar{w}$ is the average of the w_j over all industries. The important point here is that it is not necessary to have complete knowledge of the input-output table for a given state, but only to have reasonably good estimates of the proportion of the total value of the product which is spent within the state.

Similarly,

$$\mu^*_j = 1 + \frac{w^*_j}{1 - \bar{w}^*} \qquad (15)$$

is a close estimator of the total (direct, indirect, and induced) output multiplier for industry j. Here w^*_j is the same was w_j, except that here payments to households are included. That is:

$$W^*_j = W_j + a_{n+1,\ j} \qquad (16)$$

and

$$\bar{w}^* = (n[\bar{w} + \bar{a}_{n+1}] + a_{n+1,n+1})/(n+1) \qquad (17)$$

Further research[2] has shown that the multiplier estimates using equations (13) and (15) and substituting these values into the income multiplier formulas shown earlier, result in multipliers which are very reliable for any state, so long as it is possible to obtain reasonable estimates of the w_j. $\bar{w}$, $a_{n+1,j}$ and $\bar{a}_{n+1}$ used in the above formulas. Many states, including Florida[3], have input-output tables from which these values can be estimated. Also, reasonably good estimates of the $a_{n+1,j}$ and $\bar{a}_{n+1}$ can be determined from the most recent national input-output matrix[4].

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[2] Roger L. Burford and Joseph L. Katz, "Input-Output Multipliers Without a Full I - O Matrix," presented to the annual meeting of the American Statistical Association, Chicago, August 1977.

Roger L. Burford and Joseph L. Katz, "On a Distribution of Multipliers Without an Input-Output Matrix," presented to the annual meeting of the Southern Economic Association, New Orleans, Louisiana, November 1977.

[3] Unpublished. A copy was obtained from the Office of Economic Analysis, Florida Department of Commerce, Tallahassee, Florida.

3.4.2.2.2 The Employment Multipliers

Employment multipliers were developed to measure the impact of Occidental Chemical Company's current operations and planned expansion on total employment in Florida and in the immediate three-county impact area. These multipliers are based directly upon the output and income multipliers already discussed and their validity hinges upon the validity of the income multipliers discussed earlier. The approach taken here was essentially as follows.

As of 1974 and 1976, it was possible to compute for each industry and for the average of all industries in Florida, the ratio

$$r_j = E_j/I_j \tag{18}$$

E_j is the total employment in Florida in industry j as obtained from the Florida Department of Commerce. I_j is the total income earned as salaries and wages and proprietors income for Florida as published annually in the August issue of the Survey of Current Business. Thus, r_j represents, in effect, the number of employees in industry j per dollar earned from industry j.

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[4] Input-Output Structure of the U.S. Economy; 1976, "Survey of Current Business, February 1974.

Finally, to estimate the direct, indirect and induced employment impact of increases in output of each industry j from which Occidental made purchases, the following computations were performed:

Direct Employment Multiplier = $r_j j \cdot a_{n+1,j}$

Indirect Employment Multiplier = $\bar{r} \cdot \bar{a}_{n+1}(\mu_j - 1)$

Induced Employment Multiplier = $\bar{r} \cdot \bar{a}_{n+1}(\mu^*_j - \mu_j)$

Total Employment Multiplier = $r_j a_{n+1\ j} + \bar{r}(\mu^*_j - 1)$

Here $\bar{r}$ is the average ratio of employment to earned income in all industry in Florida.

3.4.2.3 Income Impacts of Occidental on Florida and the Immediate Impact Area

This section is devoted to estimation of the direct, indirect, and induced impacts of Occidental's north Florida operations on the earned incomes of people in the immediate impact area and in Florida as a whole. This is done in several stages. First, the impact of Occidental's operations during 1976 is estimated. Second, the impact of Occidental's budgeted operations for 1978 is presented, with an evaluation of change from 1976. Third, an evaluation is made of the impact of Occidental's operation in 1979, given that the Phase I expansion program is completed at that time. Fourth, an evaluation is made of the impact of Occidental's operations in 1980, given that the Phase II expansion is completed at that time. The increased impact resulting from the Phase II expansion is then evaluated. It is this impact which is relevant to the application for a permit for which this EIS is being conducted since the Phase II expansion is the plant construction for which the permit is sought.

Finally, an evaluation is made of the short-term impact of the planned construction itself. This is treated separately since its impact is only of a temporary nature as opposed to the permanent effects of the plant's operation.

3.4.2.3.1 Impact as of 1976

Occidental's impacts on incomes to individuals in Florida and in the three-county area of immediate impact are presented here in several stages. First, Occidental's role in the economy as of 1976 is shown, based on Occidental's operating data for that year. These impacts are then related to the data shown in Section 2.8, on the earned income in Florida and the immediate three-county impact area. As of 1976 Occidental's own payroll amounted to $17,822,593. Most of this figure represents income to Floridians, but approximately one million represents income to employees who live in Georgia.

The total income impact resulting from Occidental's operations was computed as indicated earlier in this section. The results of these computations for 1976 are as follows:

Direct Impact (Including OXY payroll)	$30,637,976
Indirect Impact	8,703.38
Induced Impact	15,166,053
Total Income Impact	$54,507,410

Thus, the total effect of Occidental's operation on incomes in Florida in 1976 was about 3.1 times Occidental's own payroll.

The $30,637,976 of direct income generated includes the approximately $16.8 million of Occidental payroll to Florida residents plus the income payments made by the firms which supplied Occidental with products and services. The approximately $8.7 million of indirect income represents the sum of income payments made by firms supplying Occidental's suppliers, their suppliers, and so on. The roughly $15.2 million of induced income represents the sum of income payments made by firms from whom supplier's employees make consumer purchases, also, the employees of Occidental's suppliers' suppliers, their suppliers, and so on.

Thus, the approximately $54.5 million of earnings represent the sum of incomes earned from all rounds of expenditures by businesses and consumers resulting from Occidental Chemical Company's operations during the year 1976. This figure represents about 0.2 percent of total labor and proprietor's earnings in Florida and roughly 27.0 percent of total earnings in the three counties in 1976. Figure 3.4-2 reflects the magnitude of Occidental's effects on income earned in Florida relative to the total earnings in each of the three counties and the State of Florida.

Occidental's 1976 total income impact within the three-county area of immediate impact is estimated as follows:

Direct Income Impact (Including payroll)	$21,217,420
Indirect Impact	3,781,059
Induced Impact	4,722,493
Total Impact	$29,720,772

Obviously, the total impact within the three-county area is considerably smaller than the total impact in the whole state of Florida. Yet, the total impact within the three-county area is approximately 1.7 times Occidental's total payroll, including the pay of their employees who live in Georgia. Again, Figure 3.4-1 shows what part of the total earnings in the three-county area can be attributed ultimately to Occidental. It is clear from Figure 3.4-2 that Occidental's operations within Hamilton County had a very significant impact on the economy of the area, accounting ultimately for roughly 15 percent of the earned income of the citizens of the three counties.

3.4.2.3.2 Impacts of 1978 Operating Budget

Based on Occidental's budgeted operating expenditures for 1978, and assuming that the same income multipliers are applicable as used to measure the 1976 impact, it is estimated that the combined direct, indirect, and induced income that will be generated in Florida as a result of Occidental's Hamilton County operations will amount to over $59.5 million dollars. This is almost 3.0 times their projected payroll of slightly more than $20 million in 1978. This total impact is also about $5.0 million more than their total impact in 1976. This difference results entirely from an increase in price levels and wage rates over the two year period in question. There has been a decrease in the level of Occidental's operations over this period. This $59.5 million total impact can be broken down into direct, indirect, and induced impacts as follows:

Direct Income Impact	$34,232,141
Indirect Income Impact	9,118,597
Induced Income Impact	16,140,595
Total	$59,491,333

The total impact on the three-county area of immediate impact in 1978 is expected to be as follows:

Direct Income Impact	$21,209,433
Indirect Income Impact	3,791,101
Induced Income Impact	5,039,938
Total	$30,040,472

Thus, over 50 percent of the total 1978 impact is expected to be felt within the three counties of immediate impact. This is a slightly lower percent of impact in the local area than was the case in 1976.

3.4.2.3.3 Impact of 1979 Operations and the Phase I Expansion

Occidental Chemical proposes to have Phase I of their expansion program operational in 1979. Based upon Occidental's planned operating expenditures during 1979, estimates have been made here of their total impact on imcomes in Florida and in the area of immediate impact. The estimated direct, indirect, and induced impact on incomes in Florida is as follows:

Direct Income Impact	$42,479,463
Indirect Income Impact	11,427,945
Induced Income Impact	20,857,126
Total	$74,764,534

This total figure represents an increase of $15.3 million or 25.7 percent over the 1978 impact. Occidental's own payroll is projected to increase from about $20 million in 1978 to about $24.4 million in 1979. Some of the increased impact, probably about 6.5 percentage points, will be a result of inflation but the major part of it will be the result of an increased level of production as a result of Occidental's Phase I expansion.

Occidental's 1979 impact on the income of the immediate three-county area is estimated as follows:

Direct Income Impact	$26,829,045
Indirect Income Impact	4,641,962
Induced Income Impact	6,456,447
Total	$37,927,454

This represents about a 26.3 percent increase over the 1978 impact.

3.4.2.3.4 Impact of 1980 Operations and the Phase II Expansion

The Phase II expansion represents the plant construction for which this EIS is being conducted. Thus, the impact of Phase II expansion is the impact of primary interest here.

The direct, indirect, and induced impact of Occidental's 1980 operations on income in Florida is estimated as follows:

Direct Income Impact	$56,458,428
Indirect Income Impact	15,193,021
Induced Income Impact	28,413,381
Total	$100,064,830

At the same time the direct, indirect and induced income impact on the immediate three-county area is estimated as follows:

Direct Income Impact	$37,471,691
Indirect Income Impact	6,692,666
Induced Income Impact	9,080,228
Total	$53,244,585

It is, thus, estimated that total earnings in Florida which are ultimately attributable to the operations of Occidental Chemical Company's Hamilton County operations will increase from $59.5 million in 1978 to $74.8 million in 1979 and $100.1 million in 1980. The 1978 to 1979 increase will be primarily a result of Phase I of Occidental's expansion program. The 1979 to 1980 increase of $25.3 million will result primarily from Phase II of Occidental's expansion program. Over the two

Phases of the expansion program, it is then projected that Occidental's total income impact in Florida will increase as in Table 3.4-3.

The growth shown from 1976 to 1978 reflects primarily an anticipated increase in earnings rates and inflation in the economy (about 2.2 percent per year for a productivity increase and about 6.5 percent per year for inflation)[5]. If this same earnings rate increase can be expected from 1978 to 1979 and from 1979 to 1980, then the real increase in earnings as a result of Occidental's expansion program can be expected to be about 18.0 percent from 1978 to 1979 and about 25.7 percent from 1979 to 1980. It is expected that Occidental will continue its operations at about the 1980 level over the next 20 years. Thus, these data represent the long-term impacts of increasing the level of Occidental's operations. They do not reflect the short-term construction impacts.

In Table 2.8-45 total personal income in Florida was projected to be $60,404 million in 1980. In Columbia County it was projected to be $150 million; Hamilton County, $55 million; Suwannee County, $93 million; and the three-county total, $298 million.

Table 3.4-4 contains estimates of 1980 personal income and earned income in real 1974 dollars and in estimated current dollars assuming a 6.5 percent per year average rate of inflation over the six-year period from 1974 to 1980. While it is difficult to predict inflation, much of this period has passed and the rate of inflation so far has been about 6.5 percent. Thus, it is assumed that the rate of inflation will probably be about the same over the next two years as it has been. These, again, are baseline projections which do not include an assumption that Occidental will expand their operations in Florida.

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[5] There was a reduction in real earnings because of a reduction in Occidental's employment and payroll from 1976.

By comparing the estimated income impacts of Occidental's planned Phase I and Phase II expansion with the baseline projections of current dollar total earned income in 1980, it is possible to evaluate in a more meaningful way the relative importance of this expansion to the area. Figure 3.4-2 makes this comparison. In Figure 3.4-2 it was shown that in 1976 the effects of Occidental's operations within the three-county area accounted for about 15 percent of total earnings in the area. The total impact on earnings in Florida that year amounted to over 28 percent of the total earnings in the three-county area.

Figure 3.4-3 shows that the expected 1980 impact of Occidental in the immediate three-county area will amount to just over 15 percent of the total projected baseline earned income in the area. The total Florida impact then will amount to about 29 percent of the three-county baseline projections.

Looking at the increase in total earnings resulting from the Phase II expansion only, the total Florida increase ($25 million) is about 36 percent of the total baseline income projected for Hamilton County that year, and is about 7 percent of the baseline projection for the three counties.

The three-county impact alone ($15 million) amounts to about a 4.3 percent increase in total earnings in the area over and above what would otherwise be there. Finally, it is anticipated that Occidental's operations will remain at about the 1980 level through the rest of this century unless market conditions change substantially.

3.4.2.3.5 Short-Term Impacts from Construction of New Facilities

The short-term construction impacts of the proposed expansion are of considerably less importance than the long-term or permanent annual impacts from operating the facilities. Yet there will be a rather substantial though short-term effect of construction. It is anticipated that most of the construction impacts will be felt during 1978, 1979, and early 1980. The construction impacts, if any, should be negligible after that time. According to data supplied by Occidental Chemical Company, it is expected that the total construction costs of the Phase I and Phase II expansions will be about $254 million, excluding some $20 million of interest costs during construction. Of this amount $15.2 million is to be spent on terminal facilities in Jacksonville, $73.4 is to be spent for Phase I expansions at the existing Hamilton County plant site, and $165.4 is to be spent for Phase II expansion at the Swift Creek site in Hamilton County.

Applying the appropriate income multipliers, it is estimated that the short-term construction impacts on income in Florida and the three counties are as summarized in Table 3.4-5.

3.4.2.4 Permanent Employment Impacts of Occidental on Florida and the Immediate Impact Area

As was described earlier, this section takes up the estimation of the impacts of Occidental's operations on employment within Florida and in the three-county area of immediate impact.

As stated earlier, the estimates of employment impacts are heavily dependent on the estimates of income impacts and their validity depends on the validity of the income estimates. Given the earlier work by Burford cited earlier, and given that the expenditure estimates provided by Occidental are valid, it is felt that the income impacts presented earlier and the employment impacts presented here are reasonable and as reliable as is possible.

3.4.2.4.1 1976 Employment Impact

During 1976 Occidental employed an average of some 1,304 people. By September 1977, this figure was down to 1,185. It has been estimated that Occidental's employment in 1978 will average about 1,200 people, that in 1979 this will be up to 1,350 and that employment in 1980 will be about 1,700. This, of course, is far from measuring the full extent of Occidental's expected employment impact.

In 1976, Occidental's operations at their White Springs facility resulted in total, direct, indirect, and induced employment in Florida as follows:

Direct Employment Impact	2,230
Indirect Employment Impact	698
Induced Employment Impact	1,159
Total Employment Impact	4,087

This is 3.13 times Occidental's own average employment for 1976. The total employment impact in 1976 within the three-county area of immediate impact was as follows:

Direct Employment Impact	1,532
Indirect Employment Impact	309
Induced Employment Impact	349
Total Employment Impact	2,190

This total figure is 1.68 times as large as Occidental's total employment for that year. This figure is a measure of the total number of jobs in the three-county area which is ultimately attributable to Occidental's own operations in Hamilton County.

Figure 3.4-4 puts this impact into perspective relative to the total employment in the three counties and the employment within each county in 1976. The employment data used here include nonagricultural workers who are covered by unemployment insurance. The groups that are excluded, are primarily agricultural workers and Federal government employees. It should be noted that agricultural employment is a relatively large share of total employment in the area (7.2 percent in 1975), so total employment is somewhat understated. However, since agricultural employment is not really affected by the level of Occidental's employment, nonagricultural employment is really a more appropriate base for comparison.

Clearly then, that part of the total nonagricultural employment of the three counties which can ultimately be attributed to Occidental's operations (2190 jobs) amounts to about 13 percent of all nonfarm jobs in the three-county area. The total number of jobs in the state which can be attributed to Occidental's operations (4,087) amounted to only 600 fewer nonfarm jobs than were in all of Suwannee County in 1976; 600 more (including Occidental's own employment) non-farm jobs than existed at that time in Hamilton County; or a little less than half of the number of non-farm jobs that existed in Columbia County. Clearly, Occidental makes a substantial contribution directly and indirectly (and induced) in the three-county area of immediate impact.

The employment impact, however, is actually less than the income impact. The reason is essentially that Occidental and Occidental's suppliers generally pay higher average wage rates than the average of all other jobs in the area.

3.4.2.4.2 Employment Impact in 1978

The income impacts of Occidental's budgeted operations for 1978 were presented earlier. Occidental's budgeted expenditures included an allowance for expected price level increases, as well as wage level increases. It was assumed that Occidental's suppliers' wage levels would also increase more or less proportionately to Occidental's. Thus, the ratio of employees per dollar of income impact in 1978 was computed as described earlier in this section. These data were then used, along with direct, indirect, and induced income impacts for each individual supplying industry to Occidental, to develop estimated employment impacts for Occidental in 1978. These estimates for the State of Florida are as follows:

Direct Employment Impact	2,033
Indirect Employment Impact	610
Induced Employment Impact	1,044
Total	3,687

It should be noted that the total number of jobs in Florida estimated to be ultimately attributable to Occidental in 1978 is some 400 less than was the case in 1976. This is not surprising since the level of Occidental's own employment and their operations in 1977 was less than 1976. The level of operations budgeted for 1978 is somewhat above that for 1977 but still below that of 1976.

The 1978 impact on the immediate three-county area jobs is shown as follows:

Direct Employment Impact	1,320
Indirect Employment Impact	268
Induced Employment Impact	310
Total	1,898

Thus, the number of jobs ultimately dependent on Occidental in the immediate area is expected to be some 292 less in 1978 than in 1976. Thus, most of the reduction in employment statewide is concentrated within the three counties.

3.4.2.4.3 Phase I Expansion Impact (1979)

The first phase of Occidental's expansion program is projected to be operational in 1979. Based upon the income impacts already presented and projected wage level increases in each of Occidental's supplying industries, the impacts of Occidental's operation of its expanded facilities on total employment in 1979 are as follows:

Direct Employment Impacts	2,264
Indirect Employment Impacts	703
Induced Employment Impacts	1,209
Total	4,1764,176

Similarly, the projected employment impact within the area of immediate impact is:

Direct Employment Impact	1,527
Indirect Employment Impact	330
Induced Employment Impact	372
Total	2,229

Thus, operation of the newly expanded facilities after completion of the Phase I expansion is expected to result in about 489 more jobs in Florida than in 1978. This, of course, includes an assumed increase by Occidental of about 150 employees over their 1978 employment level of about 1200. This projected addition by Occidental of some 150 jobs will result in a statewide addition of some 489 jobs in Florida (including Occidental's own increase). This represents a marginal multiplier of about 3.3; i.e., for each new Occidental job, some 2.3 more will result state-wide.

Furthermore, while a total of 489 additional permanent jobs are expected to result from Occidental's Phase I expansion, about 331 (2,229-1,898) of these will be located within the three counties (Hamilton, Columbia, and Suwannee) themselves. No attempt is made here to allocate these new jobs among the three counties involved.

3.4.2.4.4 Phase II Expansion Impact (1980 through 1998)

As noted before, it is the Phase II expansion impact which is of primary concern here. As was seen earlier, the Phase II income impact is expected to be quite significant. As is shown in the following paragraphs the effects of the Phase II expansion on jobs is also expected to be quite significant. The total employment impact in Florida expected to result from Occidental's 1980 operations is as follows:

Direct Employment Impact	2,946
Indirect Employment Impact	862
Induced Employment Impact	1,516
Total	5,324

The employment impact expected within the three-county area of immediate impact is expected to be:

Direct Employment Impact	1,950
Indirect Employment Impact	408
Induced Employment Impact	495
Total	2,853

It is assumed here that Occidental's own employment in 1980 will be about 1,700 people. It should be noted also that it is expected that, from 1980 through the remainder of the 20 year life of Occidental's contract with the Soviet Union, the employment impact of Occidental's operations will remain at about the same level.

Table 3.4-6 reflects the additional, or marginal, employment impact in Florida and in the three-county impact area that will result from Phases I and II of Occidental's expansion program.

Clearly, the Phase II expansion will have a significant effect on the number of jobs available within Florida and especially in the three-county area. In 1980, for example, the total employment in Florida which is ultimately attributable to Occidental amounts to slightly over 22 percent of the projected employment in the three-county impact area by place of residence (see Table 2.8-39). The employment impact in the three counties in 1980 (2,853) amounts to about 12 percent of the total baseline projection for 1980.

Finally, from Table 3.4-6 it can be seen that a total of over 1,600 permanent jobs will result in Florida from the combined Phase I and

Phase II expansion program and 955 of these will be located within the three-county area of immediate impact.

3.4.2.4.5 Temporary Employment Impacts During Construction

The temporary effects of Occidental's construction program on earnings in Florida and the immediate three-county area were presented earlier. Attention here is on the number of jobs that will be created temporarily during the construction phases of the project only. This includes the construction jobs on the project itself plus nonconstruction jobs resulting from purchases by the contracting firms and by the construction workers and the workers of the suppliers to the construction firms.

The temporary employment resulting from Occidental's construction program is summarized in Table 3.4-7. As was stated earlier, Phase I of the project should be completed by early 1979 and Phase II should be completed by early 1980. Thus, during 1978 it would be expected that the extra jobs in Florida which can be expected to result from Phase I of Occidental's expansion program should total roughly 4,600 jobs while in the three-county area this total should be about 2,200 jobs. During Phase II of the project, additional jobs in Florida should reach about 8,400 and in the three-county area, additional jobs should reach about 4,600.

These jobs are over and above those created through the impacts of the operation of Occidental's facilities, but they are short-term jobs, lasting only until construction is completed.

3.4.2.5 Impacts on Labor Force, Population, and Number of Households

3.4.2.5.1 The Three-County Area

In this section, the employment impacts of Occidental which have already been measured will be used to make estimates of impacts on labor force, population, and the number of households in the area of immediate impact. It was shown in Table 3.4-6 that total employment in the three-county area can be expected to decrease by 292 employees between 1976 and 1978. Increases of 331 employees in 1979, and 624 more employees in 1980 are expected as a result of Occidental's operations.

Projected employment among people living in the three counties without Occidental's expansions are 23,443 jobs in 1979 and 24,186 in 1980. These projections assumed that Occidental's employment would remain at its 1977 level of just under 1200. Given Occidental's increased impact of 331 jobs from 1978 to 1979, total employment in 1979 should be 23,774. Assuming the same growth rate as was assumed for the area without Occidental's expansion, and adding the 624 new jobs created in 1980, the total 1980 employment among residents of the three counties is expected to be 25,455.

The projections of labor force, population, etc. in Section 2.8 assumed an unemployment rate of 5 percent. Clearly, some of this unemployment will be absorbed as a result of Occidental's employment impact. It is assumed here, then, that the unemployment rate will be reduced to 4.0 percent in 1979 and 3.5 percent in 1980. It is not reasonable to expect an unemployment rate below that level. This implies a total civilian labor force in 1979 of 24,765 increasing to 26,378 in 1980.

Thus, the additional direct, indirect, and induced impact on labor force, over and above what it would be without Occidental's expansion, is as follows:

	Labor Force Without Expansion	Labor Force With Expansion	OXY Impact
1979	24,677	25,188	88
1980	25,459	26,378	919

Thus, it is estimated that, as a result of Occidental's Phase I expansion, there will be 88 more people in the labor force of the three-county impact area in 1979 increasing to 919 more in the labor force in 1980 than would be there otherwise. Most of this increase in the labor force is likely to be accomplished either by new people moving into the area from elsewhere or by young people, who would otherwise have left, staying in the area rather than moving away. In either case, the result will be an increase in net immigration with more people and more families in the three counties than would have been there otherwise.

It is assumed here that the average size family of new members in the labor force will be slightly larger than the average size of families already there. The reason is that new people coming in to take jobs (or those who would otherwise have left) are likely to be concentrated within the age range from about 20 years old up to perhaps 45, with most of them being in their 20's and 30's--the prime childbearing ages. In 1970, the number of people in the three counties per employed person was 2.745. It is projected that without Occidental's expansion this would be down to 2.625 by 1980. It is assumed that the additional permanent employees in the area will bring, on the average, two more people. Thus, it is estimated that in 1979 there will be 264 more people in the three counties than there would otherwise have been. In 1980, it is estimated that there will be 2,757 more people in the three counties than there would otherwise have been. Table 3.4-8 summarizes the estimated impacts of Occidental's expansion plan on employment, labor force, and population for 1979 and 1980.

The final item of impact to be estimated in this section for the three-county area is the impact on number of households, and thus, demand for housing. As has already been noted, it was assumed that each new worker in the area as a result of Occidental's expansion will result in three new people. Some of the new jobs in the area will be taken by people already there, thus reducing the unemployment rate. The rest of the jobs will be filled by people not already in the area's labor force. It is assumed here that, in effect, each new member of the labor force will represent a new household. Some will, of course, be single, some will be married with both husband and wife working, but most will be married with only one member of the household working.

Given these assumptions, the data in Table 3.4-9 reflect the projected housing demands in the three-county area for 1979 and 1980. Thus, it is estimated that in 1979, 88 more housing units will be required within the three-county impact area that would be needed without Occidental's

Phase I expansion. In 1980, an additional 831 units will be required over and above the additional requirements for 1979. This 831 additonal units will be required essentially as a result of the Phase II expansion.

On the other hand, as of 1970 there were 122 housing units in the three counties vacant and for sale and 428 vacant and for rent. Fifty-six percent of these were in Columbia County, 11 percent in Hamilton County, and 33 percent in Suwannee County. While there are no current data available from published sources on the availability of vacant housing or the conditions of the housing that is available, it is likely that a substantial part of the expanded housing needs can be met (at least temporarily) by the existing stock of vacant housing. The number of new housing units that will have to be built to accommodate the expanded population will, thus, be somewhat less than 919; perhaps no more than 500 to 600 units.

3.4.2.5.2 The State of Florida

While it is anticipated that there will be moderate impacts on the labor force, population, and housing within the three counties of immediate impact, it is not likely that the state-wide impacts on the labor force, population and housing will be great. It has been estimated that the total employment impacts within the state of Florida will amount to a net increase of 489 new jobs in 1979 and a net increase of another 1,148 jobs in 1980, or a total of 1,637 new jobs over the two-year period.

It has been projected that without the Occidental expansion program, there will be over 202,400 people unemployed within Florida. Therefore, it is likely that a high percentage of the new people employed within the three-county area will move in from other areas in Florida. It is also anticipated that a few of Occidental's new people, especially in certain specialized or managerial jobs, may be brought in from outside the state. It is also likely that several of the new employees will commute from Georgia, as some do now. The numbers here, however, are very small relative to the state as a whole. Thus, while there is likely to be an increase in the population of the three-county area of immediate impact, it is likely that there will be little or no net effect on the labor force or population of the state as a whole. There will be a small reduction in the rate of unemployment and an increase in the per capita income of the state.

3.4.2.6 Impact on Public Service Needs and Revenues

In this subsection attention is turned to the impacts of Occidental's expanded operations on demand for public services and thus, public expenditures, and public revenues.

3.4.2.6.1 Local Governments

As has been done in the rest of this section emphasis will be put on the impacts on the three-county impact area collectively. The reason for this is that it is difficult to say with any degree of confidence just how the impacts will be spread across the three counties, although it is likely that the distribution of impacts will be somewhat similar to their distribution in the past. It is likely that a high percentage of the new people will live in or near the existing residential centers, particularly Lake City, Live Oak, White Springs, and Jasper. Which local governments will have to provide the additional public services required by any new residents in the area, and which will benefit from additional revenues will, of course, depend on the precise locational patterns of these new residents.

3.4.2.6.2 Public Schools

The most obvious immediate public service impact will be on the public schools. Total public school enrollment within the three counties in 1975 and projected school enrollment for 1980 for the immediate impact area are shown in Table 3.4-10.

These are, of course, baseline projections, not assuming Occidental's projected expansion. It is projected, then, that there will be slightly more than one child in public school for every five people living in the three counties in 1980. Given the assumptions that the new employees in the area, as a result of Occidental's expansions, will most likely be within the age range from 20 to 40, that most will be married and have children, and that the average size of new households will be 3 as opposed to the 2.61, which was projected for the general population without the expansion, it is estimated that there will be approximately 1 new child in public schools for each 4 new people in the population. Thus, it is likely that by 1979 enrollments in the three counties will increase by about 66 students and by 1980 enrollments will be up by about 689 students.

The impact of Occidental's expansion program on school enrollment can, then, be summarized as in Table 3.4-11. Thus, it is anticipated that school enrollments as a result of the two expansions will be just under 5 percent above the baseline projections for 1980. This projection relates to the total for the three counties which will be affected directly.

It is difficult to evaluate the likely geographic distribution of the new enrollment among the three counties. It is likely that perhaps as much as 50 percent of this new enrollment will be in Columbia County with perhaps as little as 30 percent being in Hamilton.

According to Table 2.8-53, projected school expenditures within the three-county area collectively in 1980-81 will be some $23,416,000 stated in 1974 dollars. About 53 percent of this will be in Columbia County, 15 percent in Hamilton, and about 32 percent in Suwannee County. The total expenditures per student projected for 1980-81 are, then, $1,678.21 in dollars of 1974 equivalent value. Although it is difficult to predict inflation with any degree of confidence, it is likely that the compound annual inflation rate from 1974 to 1980 will be about 6.5 percent. This is about the rate that has held from 1974 to 1978. If this is the case, and if school costs escalate at the same rate then annual expenditures per student will be up to $2,527.08 by 1980-81 and total expenditures will amount to $35,260,000 even without Occidental's expansion. If the average expenditure per student applies to those students added because of Occidental, then the amount that will be added as a result of Occidental will be $1,156,287 in 1974 dollars, or

$1,741,158 in inflated 1980 dollars. It is more likely, however, that the costs will not increase proportionately to enrollments.

If the increased enrollments mean a more efficient use of school facilities, then the cost increase will be less than this amount. If, on the other hand, the increased number of students will require that new schools be built, then the costs per student may increase.

3.4.2.6.3 Other Public Services

Tables 2.8-49, 50 and 51 contain projections, in terms of constant 1974 dollars, of the costs to the local governments in the three-county impact area for providing selected governmental services. These are summarized in Table 3.4-12 for 1974 and 1980, along with projections of the impact for the combined three-county area of Occidental's expansions.

Given the nature of most local government services, and given that few if any additional streets, highways, or other public facilities will have to be constructed, it has been assumed here that the increase in cost of local services per additional new resident will be only $100 as opposed to the average cost of $138.66 without the expansion.

If it is assumed, as with school expenditures, that costs escalate at a compound annual rate of 6.5 percent, then the total cost of local government services in 1980 will be $13.2 million in current dollars in the three-county area after the expansion but would be $12.8 million without it. Still the average cost per capita should be less as a result of the expansion than it would be otherwise.

3.4.2.6.4 Local Government Revenues

It is not possible to determine precisely what new revenues will be generated for the local governments as a result of Occidental's expansion plans. This is true because, as has been shown, in Table 2.8-22, the local governments of the three counties receive the largest single component of their local revenues from intergovernmental transfers which are difficult to predict. Another large share of local revenues is derived from property taxes, and most of the remaining revenues are derived from various types of service charges. While all of these are difficult to predict, it is clear that collections from service charges (including utilities, fines, etc.) will increase at least proportionally with the services rendered.

Thus, since there are certain fixed costs associated with providing such services, it is likely that such collections will increase at least in proportion to the cost of providing additional services to the new residents in the area as a result of Occidental's expansion.

With respect to property taxes, it has been estimated by Occidental that their own property tax payments will increase from the $628,550 that they paid within the three counties ($627,471 in Hamilton County) in 1976 to about $960,000 in 1979 and to just over two million dollars in 1980. Of course, the great bulk of this will be paid to Hamilton County which will more than double their total 1974 tax collections unless they adjust their millage rates or assessment ratios to offset the increase.

The other counties will not benefit directly from this increased revenue. On the other hand, as a result of new construction of housing units for the new people coming into the area as well as additional property improvements from expanded business, the tax base in each of the counties can be expected to increase. Thus, property taxes will also increase in all three counties, though Hamilton's will increase the most by far.

To the extent that state and federal transfers to local governments are based on population, these will be increased proportionately once the increase in population has been recognized. In short, while it is possible to estimate with fair accuracy the increased local government expenditures which will be necessitated by the proposed expansion, it is difficult to predict with the same degree of accuracy the revenues that can be generated without increasing the per capita taxes on the citizens of the area. Taxes will, of course, increase to meet the needs. The question is whether or not a per capita tax increase will be necessary. It is rather clear that no such increases will be required in Hamilton County but it is not quite so clear whether or not they will be necessary in the other counties. In fact, it is likely that per capita personal taxes will decline in Hamilton County.

3.4.2.6.5 State Taxes

Occidental Chemical Company has estimated that in 1979 their own payments of sales and severance taxes to the state will reach over $4.3 million. By contrast, in 1976 Occidental paid just under $3.0 million in sales and severance taxes, net of ad valorem credits and allowances for land reclamation. Thus, the sales and severance taxes paid to the state of Florida in 1980 will be more than 50 percent greater than Occidental paid in 1976.

The above does not, however, include all of Occidental's state tax impacts by any stretch of the imagination. For example, in addition to sales and severance taxes, Occidental pays motor vehicle fuel taxes, income taxes, and others. No information has been provided by Occidental on what they expect to pay for these.

Moreover, sales tax (and others) paid by individuals are related to their levels of income. For example, in 1974-75, total state sales tax collections in Florida amounted to $1,199,521,000. That same year income earned by Floridians was $33,824,000,000. Thus, sales tax collections amounted to 3.55 percent of total earned income in the state. Assuming this percentage to still hold (i.e. no major changes in the tax rates), it is estimated, given the income impact estimates of Table 3.4-3, that increases in state sales tax collections from 1978 to 1979 as a result of Occidental's Phase I expansion impact on income will be about $542,200 per year. In addition, it is estimated that the increase in sales tax collections as a result of Occidental's Phase II expansion impact on income will be about $898,161. Thus, the increase from 1978 to 1980 will be about $1,440,361. This does not include Occidental's own sales tax payments.

With a total direct, indirect, and induced income impact in 1980 of $100,064,830, it is estimated that Occidental will be responsible for about $3,552,300 in sales tax collections in the state in addition to their own expected payments of some $4.6 million payments in sales and severance taxes.

This is by no means a complete accounting of state tax revenues generated as a result of Occidental's operations. Nor has there been an accounting here for increased costs to the state except in the form of transfers to the local governments to cover increased costs of public schools and other public services. Just what additional costs there might be are difficult or impossible to determine exactly. However, as has already been stated, it was not anticipated that the population of the state as a whole would be increased appreciably if at all as a result of the Occidental expansion. This being the case, it is not likely that the state governments total costs will increase either although the allocation of their local government transfers among the counties might be affected. Indeed, their costs might actually decline as a result of decreased unemployment. Finally, it is possible, on the other hand, that the state's costs of environmental monitoring might be increased to some degree as a result of the project but the degree to which this might happen is not clear.

3.4.2.7 Impact of Occidental's Planned Expansions on Land Use

In Section 2.8, projections were made of the increases in population and housing, and the consequent shifts in land use that can be expected in the three-county impact area as a result of normal growth. There, it was assumed that the planned expansions in Occidental's facilities in

Hamilton County would not be carried through. It was projected there that new residents would be settled somewhat more densely as a result of the relative reduction of land available for residential uses. As of 1976, considering all three counties in the impact area collectively, there was an average of some 0.54 acres of land in residential uses per household, or about one fifth of an acre per person.

If the new households formed in the area as a result of Occidental's expansion use only 0.4 acres of land as opposed to 0.54 acres, then it can be expected that some 35 acres will be converted to residential uses as a result of the 1979, Phase I expansion and some 333 new residential acres will result from the Phase II expansion. It is this latter figure which is relevant for this EIS. Taking both of these together, then some 368 acres of residential land might be developed in the three counties. Probably close to half of this will be in Columbia County in or near Lake City. Most of the remainder is likely to be in or near the other urbanized areas of the three counties. This 368 acres amounts to only a 3.6 percent increase in the current residential acreage as a result of both phases of the planned expansion. It also represents less than 3 acres out of every 10,000 of the total land area in the three counties, clearly not a significant increase in residential land usage.

It is, of course, also likely that there may be some increase in commercial land use as well, as a result of the expanded population. There is likely to be little or no increase in industrial, transportation, or communication and utility land use. There might be a slight increase in institutional or recreational land use but the extent to which this might occur is difficult at best to determine. As with the residential land use increases, most of the increases which may result in commercial, institutional, or recreational land use are likely to occur in or adjacent to existing commercial or urbanized areas. In fact, there are relatively large amounts of undeveloped land within the existing cities enough so that all foreseeable new residential, commercial, and other developments of land could easily be accommodated there without requiring any expansion into the sourrounding country side. In short, it is almost inconceivable that the growth impacts which have been projected could cause any serious reductions in the amount of land in agricultural, forest, wetland or undeveloped uses. The area to be mined is already classed as in extractive uses.

3.4.3 DESCRIPTION OF ECONOMIC BENEFITS AND PRODUCT MARKETS

This section concerns itself mainly with the national economic benefits to be derived from the proposed project, as opposed to the local benefits which have already been discussed. The first part deals with the international trade implications of the project and the effects on U.S. imports, exports, balance of trade, and balance of payments. The second part deals with the world and national supply and demand situation for the three primary fertilizer components, the relative availability of resources for their production, and the energy trade-offs involved in the production of phosphate based fertilizers vis-a-vis nitrogen fertilizer.

3.4.3.1 International Trade Implications of Planned Expansion of Occidental and Trade with the Soviet Union

3.4.3.1.1 Introduction

This part of the study deals with the international economic implications of the trade agreements between Occidental and the Soviet Union and with the national energy implications of the proposed trade agreements.

In particular, the international economic implications will focus on the impact on the U.S. balance of trade and balance of payments given that the agreements are fully carried out. Additionally, this section will focus on the rationale for trading Florida phosphate to a foreign country and will critically examine this rationale. This will naturally lead to a discussion of the U.S. and world markets for fertilizers. Finally, the energy requirements for producing phosphates, ammonia, urea, and potash will be compared and the energy trade-offs of the proposed agreements will be examined.

Later sections of this study will cover the basic agreements between Occidental and the Soviet Union; the international economic implications of the agreements; the U.S. and world fertilizer marekts; and the energy trade-offs of the proposed agreement.

3.4.3.1.2 Occidental-Soviet Union Trade Agreements

Occidental Peteroleum (of which Occidental Chemical Company is a subsidiary) signed six trade agreements with the Soviet Union dealing with phosphates, ammonia, urea, and potash. These agreements can be outlined as follows:[1]

(1) Two agreements for design, engineering, procurement of equipment, and construction of ammonia and super phosphoric acid terminals at:

  a) Ventspils on Baltic Sea

  b) Odessa on Black Sea;

(2) Urea and Potash agreement providing for Soyuzpromexport to sell and Occidental to buy 1.0 million metric tons per year of urea and potash for 20 years beginning in 1978;

(3) Ammonia agreement providing for Soyuzchimexport to sell and Occidental to buy 1.5 million metric tons for 20 years beginning in 1978;

(4) Superphosphoric acid agreement providing for Occidental to sell and Soyuzchimexport to buy 1.0 million metric tons of SPA for 20 years beginning in 1978; and

(5) Ammonia agreement providing for Soyuzchimexport to sell and Occidental to buy 0.6 million metric tons of ammonia for 10 years beginning in 1978. This agreement was

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[1] Occidental Petroleum Corporation, OXY/SPA project, "Authorization for Expenditure", prepared by Hooker Chemical Corporation, Agricultural Products Group, Planning Department, October, 1977.

modified so that Occidental may buy additionally up to 0.4 million metric tons of ammonia. This modification takes effect only if the original purchase does not provide the Soviet Union with an annual income of $900 million.

The agreement of importance to the three-county area in northern Florida (Columbia, Hamilton, and Suwannee Counties) is, of course, the agreement concerning SPA. The phosphate rock will be mined from Occidental's mines in Hamilton County and this rock will be processed in Occidental's plants in Hamilton County. Some of the economic benefits of the mining and processing of the phosphate will accrue to those persons living in this three-county area, as already discussed.

The agreements for ammonia, urea, and potash are important from a larger perspective: (1) from the point-of-view of the international trade implications for the United States; (2) from the viewpoint of the overall fertilizer market; and (3) from the perspective of the energy requirements for producing the alternative commodities.

3.4.3.1.3 The Occidental-Soviet Union Agreements and the U.S. Trade Position

A proper appreciation of the international implications of the Occidental-Soviet Union agreements is especially gained after recognizing the consumption and production of the traded commodities in the United States.

3.4.3.1.3.1 A Perspective on U.S. Consumption, Production and Foreign Trade -- The domestic consumption of fertilizers has grown steadily over the last fifteen years (1962 through 1976) and is documented in Table 3.4-13. This fact is significant for phosphates, ammonia, urea, and potash since the primary use of these commodities is in manufacturing chemical fertilizers. Between 75 and 80 percent of all ammonia used in the United States is for fertilizers.[2] This fraction is even higher for the rest of the world. Of the almost 34 million short tons of phosphate rock mined in the United States in 1976, only 5.5 million short tons were used for non-agricultural purposes.[3] This amounts to less than 20 percent of domestically produced phosphates being used for non-agricultural purposes. Urea is synthesized from carbon dioxide and ammonia so the basic ingredient to be concerned about is ammonia. Almost all potash is produced for agricultural purposes. Significantly, the United States produces enough potash for 20 to 25 percent of its needs, with the rest coming primarily from Canada.[4]

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[2] See John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), pp 88-94 and John R. Douglas, "The North American Fertilizer Situation, Mid-1977", paper presented to Annual Meeting of Quebec Fertilizers, Inc. (June, 1977).

[3] See John R. Douglas and E.A. Harre, "Patterns of Phosphate Rock Production and Use", prepared for National Research Council - TVA Symposium (February, 1977).

[4] See Douglas and Davis, "Fertilizer Supply and Demand", op. Cit. A more detailed picture of the potash industry can be found in Robert E. Watner, "The Outlook for Potash Fertilizer", Situation 77, TVA Fertilizer Conference (July, 1977), pp 28-35.

The domestic consumption of nitrogen fertilizer (ammonia, urea, etc.) grew at an average conpounded rate of 7.8 percent over this fifteen year period, while the consumption of phosphate fertilizers grew at an average compounded rate of 4.3 percent and the consumption of potash fertilizers grew at an average compounded rate of 5.7 percent. This growth in the consumption of fertilizer is compatible with the growth in the production of agricultural commodities for use in the United States and for exports to many other countries. Since land is limited in terms of total number of acres, the solution for an expanding farm output is to make each acre more productive.

Production of nitrogen fertilizer materials, phosphate, and potash in the United States is given in Tables 3.4-14, 15 and 16. The production of anhydrous ammonia, the basis for a large majority of nitrogen fertilizer materials, grew from 1962 to 1975 at a rate of 7.7 percent per year. This average growth rate is somewhat deceptive because from 1962 to 1972 the production of anhydrous ammonia grew at a rate of over 9.0 percent, while from 1972 to 1975 the production of anhydrous ammonia has grown at less than 2 percent per year.

The average compounded growth rate of production of phosphate rock from 1962 to 1975 was 7.1 percent for North Carolina and Florida and around 6.0 percent for the entire United States. World production grew at a 6.6 percent compounded annual rate from 1962 to 1974. Hence, over this time U.S. production fell modestly as a percentage of world production from 40.7 percent in 1962 to 37.6 percent in 1974. Phosphate mining is done in several areas of the world, the United States, North Africa, the U.S.S.R., and the Pacific islands, and regions other than the United States have been developing their mines. This is particularly true in North Africa.[5]

Potash production in the United States and Canada is tabulated because there has been a major alteration in potash production since 1962. The United States is producing approximately the same amount of potash in the mid-1970's as it did in 1962. Canada, on the other hand, has increased its production of potash at a phenomenal rate.

To bridge the gap between production and consumption a country may export or import. The record of the United States in terms of exports and imports of nitrogen fertilizer materials, phosphate fertilizers, and potash is presented in Table 3.4-17. The record is very clear in terms of phosphate fertilizers and potash. The United States is an exporter of phosphate fertilizers and an importer of potash. Nitrogen fertilizer materials do not offer a clear choice since the United States has been a net exporter and is currently a net importer of such fertilizer materials. The answer to the question in the case of nitrogen fertilizer materials may be the scarcity of the feedstock - that is, natural gas - in different parts of the world.

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[5] See John R. Douglas and E.A. Harre, "Patterns of Phosphate Rock Production and Use", op. Cit.

The United States is quickly depleting its known reserves of natural gas and so are many other countries.[6] Some countries, however, such as Mexico and the Soviet Union appear to have a surplus of natural gas at this time.[7] Hence, there might be a chance to import nitrogen fertilizer materials from countries with an abundance of natural gas. Purchasing nitrogen fertilizer materials is an indirect way of importing natural gas.

These facts should prove helpful in examining the impact of the Occidental-Soviet Union trade agreements on the U.S. balance of trade.

3.4.3.1.3.2 The International Trade Implications -- The implications of the trade agreements between Occidental and the Soviet Union for the United States depend on what actually transpires. It is obvious that Occidental will ship superphosphoric acid to the Soviet Union; in other words, the phosphate from Florida will eventually end up in the Soviet Union. In exchange, Occidental will receive ammonia, urea, and potash, and these commodities will be returned to the United States if the proper market conditions prevail.[8] Such market conditions may not prevail at all times during the period of the agreements, in which case Occidental can sell the commodities in other countries. Additionally, the agreements are written in terms of quantities; one million tons of phosphate per year, etc. Occidental anticipates that the proposed quantity of phosphate shipped to the Soviet Union in exchange for the quantity of ammonia, urea, and potash will be approximately equal in terms of dollars.[9] These predictions may not hold for twenty years. There is no way to evaluate the likelihood of these predictions. There are provisons in the agreements for adjusting the quantities to be shipped from time to time, depending on world prices. Various trade possibilities are outlined below.

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[6] Natural gas reserves in the United States are documented in Figure 3.4-6 and the related text.

[7] Natural gas reserves in the Soviet Union are documented on page 3-211 of this study.

[8] Occidental has suggested that all of the ammonia, urea and potash that is shipped from the Soviet Union may be marketed in the U.S., but Occidental has never made an immutable commitment on this point; this is the impression gathered from private conversation between Dr. Roger Burford and the officials of Occidental. Whether or not these materials are brought into the U.S. will depend upon the market conditions that exist at the time.

Case I: U.S.-U.S.S.R. Trade, no other countries involved, exchange equal in value.

Case I is the simplest case in terms of transactions. Occidental ships phosphate fertilizer to the Soviet Union and, in return, the Soviet Union will provide Occidental with ammonia, urea, and potash. Occidental will market all of the commodities in the United States and it will also be assumed that the transactions are equal in dollar amounts.

Over the twenty years of the agreements the above transactions will have no direct negative or positive impact on the U.S. Balance of Trade.[10]

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[9] This is implied in the "Authorization for Expenditures", Occidental Petroleum Corp., prepared by Hookers Chemical Corp, Agircultural Products Group, Planning Department (October, 1977).

[10] The Balance of Trade is defined as exports minus imports and compares the exporting and importing of commodities, finished products and services. The Balance of Payments takes into account the export-import transactions, but also financial transactions such as buying bonds.

The U.S. releases it rights to the phosphate but gains rights to ammonia, urea, and potash. Assuming that both parties are acting in their own self-interest, then the trade should be beneficial to both countries. The United States receives ammonia, urea, and potash less expensively than if the U.S. tried to manufacture these products domestically.

There are several indirect effects of the above transactions.[11] The agreements call for the Soviet Union to ship 1.0 million metric tons of potash to the United States. This represents potash that may have been bought from Canada. If the potash had been bought from Canada, the U.S. would have given dollars to the Canadians and the Canadians would use the dollars to buy U.S. produced goods. Potash for phospate fertilizer or potash for dollars (and sooner or later U.S. produced goods) - the end result of the trade is the same. The United States must surrender some of its own resources or goods and services in order to get potash.

Another indirect effect is the impact of the ammonia, urea, and potash on agricultural yields. The United States has an internal capacity to produce phosphate fertilizers and appears to have more than enough capacity to produce the current needs of the U.S. farmer.[12] The United States may confront very acute shortages of ammonia because of the natural gas shortage. Any fertilizer shortage will have an adverse impact on agricultural yield which, in turn, will affect the U.S. Balance of Trade since the U.S. exports farm commodities. Farm exports assist the United States in paying for its imports such as wine from France or oil from Saudi Arabia. The United States would be forced to reduce its imports or persuade foreign countries to hold dollar-denominated financial assets if its agricultural exports fell. Any difficulties in obtaining foreign oil, of course, could lead to reduction in the real growth of the U.S. economy plus a ratcheted rate of inflation.

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[11] Mr. John R. Douglas, Assistant to the Manager, National Fertilizer Development Center, Tennessee Valley Authority, suggested several of these indirect implications in personal correspondence with Dr. Roger Burford of Economic and Industrial Research, Incorporated.

Another indirect impact of the trade concerns the expansion of the phosphate facilities in Florida and the greater employment and higher income that will accompany this expansion. Persons earning higher incomes will tend to buy more domestically produced goods and more foreign produced goods or imports. This, however, would also happen if the new facilities produced phosphate fertilizer for U.S. use. Hence, the Occidental-Soviet Union trade agreement will cause this import effect only if it results in a net increase in income over and above what would result without this trade.

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[12] This appears to be true in terms of phosphate rock reserves and industrial capacity. This problem will be dealt with more extensively in a later section of this study. For a short run assessment of the capacity situation, see John R. Douglas and J. Harold Parker, "Phosphate Industry Rebounds", National Fertilizer Development Center, Tennessee Valley Authority (April, 1977) and John R. Douglas, "Changing World Phosphate Supply Capacities", National Fertilizer Development Center, Tennessee Valley Authority, prepared for Sulfur-Phosphate Symposium, Monte Carlo (March, 1977).

Case II: U.S.-U.S.S.R. Trade, Other Countries Involved,
exchange in equal value.

In this hypothetical case is is assumed that the United States provides the Soviet Union with phosphate fertilizer and receives ammonia, urea, and potash in exchange. Occidental, however, does not sell the ammonia, urea, and potash in the United States; rather, they sell the commodities to other countries.

Even in this case, the United States must get some product or service in exchange for the phosphate, unless Occidental decides to hold the foreign currency in which it was paid as a financial asset. The process by which the United States ultimately receives a product or service can be charted in Figure 3.4-5.

Occidental mines and processes the phosphate, paying the workers and other expenses because of their expected revenues from the sale of the phosphate. The phosphate is shipped to the Soviet Union. The Soviet Union does not pay in cash, but rather in ammonia, urea, and potash. These commodities now belong to Occidental, and Occidental decides to sell them to another country. This country pays Occidental in its currency. Occidental can now purchase commodities from this country and ship the commodities back to the United States.

What happens if Occidental decides to construct a plant or open a mine in this foreign country? Even in this case, products and services will eventually flow to the United States. The investment in the foreign country will yield a profit and as the profits are repatriated, the United States will receive goods and services from foreign nations in payment for the phosphate exports. This case does not suggest a year-in-year-out trade balance, but over a long period of time the export-import trade will balance out.

The point should be clear. The United States receives something in return for providing the Soviet Union with phosphate fertilizers. In Case I, what the United States receives and when it receives the products are clear. The United States receives ammonia, urea, and potash and receives them the same year that the phosphate is delivered to the Soviet Union. In Case II, the United States still receives goods and services from abroad, but what they will be and when they will arrive are not definite.

Case III: U.S.-U.S.S.R. Trade, no other countries involved, exchange not equal in value.

In this hypothetical case the United States and Soviet Union make the trade as proposed, but now the value of the phosphate fertilizer exceeds the value of the ammonia, urea, and potash, or vice-versa. First, Occidental and the Soviet Union could modify the quantities written into the treaty. Second, the parties could agree to settle the differences with cash payments. But in any case, the value of the U.S. export will be completely offset by the value of the U.S. import.

3.4.3.1.3.3 The Benefits of Foreign Trade -- Foreign trade between two countries is quite similar to economic exchange between two parties within the same country. Both sides gain if both parties are operating for their maximum gain. Occidental is proposing to trade phosphates to the Soviet Union in exchange for ammonia, urea, and potash because Occidental believes ammonia, etc., are more valuable to them than the phosphates. The Soviet Union must believe just the opposite from its perspective. If so, both parties come out ahead on the same trade.

Foreign trade must be examined from the perspective of the United States as well as Occidental. That is, is the trade in the long run interests of the country as well as the company?[13] This perspective leads to an analysis of the scarcity of the respective resources involved and the uses of the resources. In other words, is Occidental trading away a natural resource which may be very scarce and very vital in the not too distant future? If the proposed trade can be considered harmful it can only be from this viewpoint; otherwise, as shown above, foreign trade leads to gains for both involved parties.

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[13] The United States Department of Commerce has indicated that it thinks so by granting a permit to Occidental to carry out the trade agreement with the Soviet Union.

3.4.3.2 Resource Reserves and the Supply and Demand of Fertilizers

International trade leads to both parties improving their relative status, otherwise the trade would not have been completed. However, trade, involving a state's and a nation's depletable natural resources, should be examined very closely to insure that long-term difficulties are not being created in order to accrue short-term gains. This section examines the proposed trade between Occidental and the Soviet Union from a long-run perspective. The discussion centers around the basic resources involved, namely phosphate rock, sulfur, and natural gas, and the commercial use of these resources from Occidental's point-of-view, namely, the fertilizer market.

3.4.3.2.1 Phosphate, Sulfur and Natural Gas Reserves

3.4.3.2.1.1 Phosphate -- The world phosphate rock industry is divided into four significant producing regions -- the United States, the Soviet Union, Africa, and the Pacific Islands.[14] The deliveries of phosphate rock by these production regions is presented in Table 3.4-18.

These regions also have the productive capacity to convert the phosphate rock into phosphoric acid (P_2O_5). In 1976 the United States and Canada had the productive capacity to produce nearly 10 million metric tons of P_2O_5 while their total consumption plus exports equaled only around 8 million metric tons; Western Europe had the capacity to produce around 9 million metric tons of P_2O_5 while their domestic use and exports totaled slightly less than 6 million metric tons; non-Communist Asia had the capacity to produce less than 3 million metric tons but with projected capacity to be around 5 million metric tons by 1980; and both Africa and Latin America had small productive capacities as of 1976 but had planned expansions through 1980.[15] The Soviet bloc countries disclose little information, but most observers suggest that these countries will have to (1) construct more basic plants, (2) increase the operational rate of existing plants, (3) decrease their rate of use of phosphate fertilizers, and/or (4) import more phosphate fertilizers in order to cover their domestic use of phosphate fertilizers.

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[14] For a discussion of phosphate activities around the world, see John R. Douglas and E.A. Harre, "Patterns of Phosphate Rock Production and Use", paper presented to National Research Council-TVA Symposium (February 24-25, 1977).

Capacity can also be analyzed in terms of the phosphate rock that can be processed. Capacity from this perspective is illustrated in Table 3-4-19. The capacity rates suggest that from a world perspective production can increase within the United States. It is very important, however, to know who is doing the estimating and the assumptions that they are making. The estimates may be biased upward or downward, depending on these assumptions.

The United States has only about 12 percent of the world's reserves and only 6 percent of the world's identified resources. U.S. mines are being worked more vigorously because of the quality of the ore and the relative cheapness of mining U.S. mines vis-a-vis the mines in other countries. The United States still has an abundance of phosphate by any measure. At current consumption rates, the United States could provide phosphate to the entire world for forty-one years - this is assuming no other country produces phosphate and the sub-economic resources become economic. The U.S. phosphate industry can continue the current production rate for domestic consumption and exports for the next sixty-six years using only known reserves and for the next one hundred years using the reserves plus the identified sub-economic resources. This does not even include rather substantial quantities of sub-economic and submarginal reserves which cannot be mined and processed with current technology and at present prices, but methods and procedures will surely be improved if prices are allowed to rise. There may, of course, be a geological limit to what can be mined from the submarginal resources and there may be unacceptably high environmental costs of mining and processing these resources. But the United States has a choice between using these reserves or not using them. Even without the sub-economic and submarginal resources, the United States still has a rather substantial store of phosphate reserves.

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[15] John R. Douglas, "Changing World Phosphate Supply Capacities", prepared for Sulphur-Phosphate Symposium, Monte Carlo (March 15-17, 1977).

The general trade position of the United States over the past two decades certainly suggests a lack of alarm over trading away a scarce depletable resource. As indicated in Table 3.4-17, the United States has exported large quantities of phosphate fertilizers since 1962.

The distribution of the phosphate reserves across the United States is presented in Table 3.4-21. Florida has 37.5 percent of the measured reserves in the United States and slightly over 10 percent of the total identified resources in the United States. Occidental has projected that in order to meet their commitment of supplying the Soviet Union with superphosphoric acid as called for in the trade agreements, they will have to mine eighty million tons of phosphate rock.[16] This represents 6.7 percent of Florida's measured reserves and 4.5 percent of Florida's total identified phosphate resources. The Occidental - Soviet Union transaction will deplete 2.5 percent of all U.S. reserves and 1.6 percent of all U.S. identified resources as identified in 1975. These reserves are based on 1975 prices and 1975 technology.

The world reserves and the U.S. reserves quoted above are based on projections by the Bureau of the Mines and U.S. Geological Survey.[17] Some industry officials consider these estimates to be conservative.

But, even with these conservative estimates, the United States has a rather substantial supply of phosphate rock. There is no immediate or even fairly distant prospect of running short on phosphate fertilizers because of the lack of phosphate rock. The trade of superphosphoric acid to the Soviet Union by Occidental will not significantly affect this assessment.

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[16] Statement of Dr. Armand Hammer, Chairman of Board and Chief Executive Officer, Occidental Petroleum Corp., before the Subcommittee on International Finance, Committee on Banking, Housing and Urban Affairs, U.S. Senate, 93rd Congress, Second Session (April 26, 1974).

[17] One has to be careful in comparing reserve estimates given by various sources since what is included in the reserve estimates, assumptions about prices, and assumptions about technology may all differ. The reserve estimates put out by the Bureau of Mines and U.S. Geological Survey tend to be very conservative and hence serve as an excellent reference point in discussing the long-term prospects for phosphate in the United States.

This assessment can be substantiated in another way. Assume that phosphate consumption grows for the next twenty years at a 5 percent annual rate, slightly higher than the 4.3 percent growth in phosphate consumption from 1962 to 1976. If no new reserves were discovered and no technological innovations were made over the next twenty years, the United States would still have over 1,500 million short tons of measured reserves and over 3,000 million short tons of identified resources at the end of the twentieth century. There is no compelling reason to conserve this resource for only domestic consumption at this time because of its scarcity.

3.4.3.2.1.2 Sulfur -- In 1975, sulfur consumption in fertilizer production was 6.6 million long tons, of which 6.1 million was connected with phosphate processing. The projected consumption of sulfur in 1985 is 15.3 million long tons with 9.3 million slated for fertilizer use, or 60.7 percent of all sulfur use is in fertilizer production.[18]

The supply of sulfur will be augmented in the 1980's and beyond by recovery of sulfur from other raw materials and as a by-product. Hence, when sulfur available in coal, crude oil, sour gas, and pyrites is included, the U.S. sulfur resources are immense.[19] In general, sulfur will not cause any curtailment of fertilizer production in the short or long run. U.S. sulfur supplies are sufficient to permit agricultural and non-agricultural users to be amply satisfied.

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[18] John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), p 94.

3.4.3.2.1.3 Natural Gas Reserves -- Almost all nitrogen fertilizer is derived from ammonia. About one third of this ammonia is directly applied, and the remainder goes to produce such products as ammonium nitrate, urea, and several mixtures. Most U.S. ammonia capacity is based on natural gas reforming.[20] About 38,000 cubic feet of natural gas is required per ton of ammonia with close to 70 percent of this used for feedstock and the rest for the energy required in the production process.[21] It is obvious then that natural gas reserves are important in an overall discussion of the fertilizer market.

The natural gas problem is, of course, current news with shortages occurring during the winter months, prices rising for new natural gas, especially in intrastate markets, and a gradual reduction in immediacy of the problem has already struck the fertilizer industry since there have been curtailments of natural gas to fertilizer plants. All fertilizer plants using natural gas as a source of energy are subject to curtailments, but ammonia fertilizer plants have suffered curtailments even though they have a very high priority, right next to households, hospitals, and similar institutions. These news-worthy problems do suggest that natural gas supplies may be more tenuous, especially in the long run than phosphate supplies.

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[19] John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), p 94.

[20] Ibid.

[21] Ibid.

Natural gas reserves and natural gas production are plotted in Figure 3.4-6.[22] Natural gas reserves have declined substantially since 1967. Reserves have declined by almost 100 trillion cubic feet in less than ten years. Production peaked in 1970 and has gradually declined through 1974. In 1974, the United States used 21.2 trillion cubic feet of natural gas for residential, commercial, industrial, transportation and utility use. At this rate of consumption, the United States has sufficient natural gas reserves to last for only ten years - this, of course, assumes no new discoveries and no additional conservation efforts.

Projections for natural gas production through 1989, as estimated by the Federal Energy Administration are given in Figure 3.4-7 for alternative prices per thousand cubic feet of natural gas. In all cases natural gas production starts declining before 1989. If the price per thousand cubic feet is $2.80, the decline does not come until 1985, but if the price is $2.00 per thousand cubic feet, the decline comes in the early 1980's. Most observers agree that the natural gas situation is not likely to improve in the next five to ten years, especially if restrictive price controls are maintained.[23]

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[22] For an excellent discussion of estimating and defining hydrocarbon reserves, see G.C. Bankston, "Estimating and Defining Underground Hydrocarbon Reserves", In a group of papers prepared under the auspices of the American Petroleum Institute's Committee on Reserves and Productive Capacity (April, 1975), pp 31-41.

The declining reserves and the falling production suggest that nitrogen fertilizers are apt to lose their feedstock if the situation does not switch around. There are, however, certain offsetting factors that do not suggest quite as bleak a future.

First, ammonia production accounts for about 70 percent of the total energy consumed in the overall U.S. chemical fertilizer industry, but less than 3 percent of U.S. natural gas is used by ammonia plants.[24] Hence, in 1974 ammonia plants used less than one trillion cubic feet of natural gas. Second, rather substantial gas fields have been discovered in Mexico and some of this gas will be piped to the United States.[25]

Third, natural gas cannot be transported very easily in its natural form, but it can be imported in the form of ammonia, such as the proposed Occidental-Soviet Union trade. This does not encourage domestic producers of ammonia, but it does encourage farmers who need nitrogen fertilizers.

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[23] Not everyone is equally pessimistic about the natural gas problem. For another view, see Joseph P. Sullivan, "U.S. Natural Resources and their Impact on Fertilizer Production", Proceedings 1977 World Fertilizer Conference (September, 1977).

[24] Douglas and Davis, Fertilizer Supply and Demand. p 93.

[25] Joseph P. Sullivan, "U.S. Natural Resources and Their Impact on Fertilizer Production", p 93.

The first circumstance means that the fertilizer industry is not a massive user of the nation's natural gas so domestic fields may be able to satisfy the demand for natural gas by the fertilizer industry. The second and third circumstances are hedges against even more startling downturns in domestic gas production. The fertilizer industry can import natural gas, which is something utilities, homes, and many other businesses cannot do (except Mexican natural gas that is piped in).

3.4.3.2.2 Summary of Reserves[26]

The United States has ample phosphate reserves[27] and less than ample natural gas reserves. The phosphate reserves are documented by industry and government. Natural gas reserves are documented, but many people believe that once price controls are lifted natural gas reserves will rise.

This may be true, but no one can be definitive about the natural gas which may be discovered. Prudence and profit from the point of view of the company and the country should lead to a trade of the plentiful resource for the scarce resource. At this time, and given the present state of knowledge, phosphates are certainly a legitimate export and ammonia a legitimate import.

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[26] Potash is being ignored at this point in the analysis since most of the potash used in the U.S. is imported from Canada, and Canada has ample reserves of potash to service its agricultural requirements and the agricultural needs of the U.S.

[27] For a slightly different view of the phosphate reserve position, see Joseph P. Sullivan, "U.S. Natural Resources and Their Impact on Fertilizer Production", pp 22-24.

3.4.3.2.3 The Fertilizer Market

Phosphate rock, sulfur, potash, and natural gas are the ultimate prerequisites for a viable fertilizer industry. These basic resources are available, either domestically or internationally, for use in the U.S. fertilizer industry. Several additional factors about the fertilizer trade should be examined in order to gain a complete picture of the fertilizer industry -- first, an estimate of productive capacity and second, a suggestion about the trend in fertilizer use. The basic raw materials, the productive capacity, and the underlying demand for fertilizer will in large part determine the price that farmers will be forced to pay for their fertilizer requirements.

3.4.3.2.4 Productive Capacity in Fertilizer Industry

3.4.3.2.4.1 Phosphate Fertilizers -- The phosphate fertilizer industry experienced a good deal of alarm and fear during the mid-1970's.[28] Rather wild guesses, at least in hindsight, suggested substantial increases in capacity but large reductions in demand. As it turned out, both productions were wrong and a sense of normalcy has returned to the phosphate industry allowing for more reliable and objective projections throught the early 1980's. The general reduction in phosphate demand in 1975 was reflective of the downturn in the U.S. economy plus many major foreign economies and was not an ominous sign to the phosphate industry.

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[28] For a discussion of the phosphate fertilizer industry in the mid-1970's, see John R. Douglas and J. Harold Parker, "Phosphate Industry Rebounds", National Fertilizer Development Center (April 1977).

This downturn did have an effect on capacity plans, however. In Figure 3.4-8, capacity estimates prepared in 1976 and 1977 for North America (primarily the United States) and the world are compared. Plans to open up new plants, reactivate old plants, or intensify production of existing plants were scaled down by firms in the phosphate fertilizer business.

There is still room for production to expand within the existing capacity since the capacity utilization rate of U.S. plants is only slightly over 90 percent currently and the capacity utilization rate for the world is slightly under 90 percent with the 1972-1974 operational ratios representing 100 percent.[29] There are still several closed plants that can be re-opened to give the United States additional capacity if needed immediately.[30] New plants will have to be constructed in the late 1970's or early 1980's if the expected growth in demand is to be fulfilled. These plants must be on the drawing boards now if they are to be constructed by the early 1980's.

3.4.3.2.4.2 Nitrogen Fertilizer -- In 1960, the average ammonia plant could produce less than 300 tons per day, but by 1977 over 60 percent of all ammonia plants could produce over 1,000 tons per day.[31] The industry, within the last several years, has started a new round of ammonia plant construction, partly in reaction to high prices for nitrogen fertilizers in 1973-74. In fact, since the middle of 1976 the capacity for ammonia production in the United States has jumped by over 15 percent or by 2.9 million tons.[32] Canada's capacity has jumped by over 70 percent, admittedly from a smaller base than the base in the United States.[33] Projected ammonia capacity through 1980 in the United States is given in Table 3.4-22. From 1975 through 1980, this represents an average annual growth rate of 5.4 percent.

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[29] Ibid.

[30] Ibid.

[31] John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977).

The projected capacity gain of around 5.5 million tons of ammonia per year from 1976 through 1980 appears to be adequate to cover both industrial and fertilizer needs.[34] If operated at 87 percent of capacity (the current average use rate), the new plants will add 4.8 million tons to 1980 supplies.[35] At current demand projections the existing and projected capacity should be sufficient to handle the required ammonia supply.

There are several factors, however, that temper this conclusion. First, there are the possible natural gas curtailments mentioned earlier and second, the inevitably higher prices for natural gas may cause some ammonia producers to cut back on ammonia production and sell the natural gas in a secondary market. Finally, obsolescence could cause some plants to shut down; by 1980 plants producing over 20 percent of all ammonia will be over 15 years old.[36] Uncertainty in the nitrogen fertilizer market hinges on the uncertainties concerning the feedstock (natural gas) and the uncertainty concerning the condition and capability of some of the older plants.

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[32] G.C. Matthiesen, "The Outlook for Nitrogen Fertilizers", Situation 1977, TVA Fertilizer Conference, Kansas City, Missouri (July 26-27, 1977).

[33] Ibid.

[34] Douglas and Davis, "Fertilizer Supply and Demand", p 91.

[35] Ibid.

3.4.3.2.4.3 Potash -- Imports of potash from Canada have grown substantially since the mid-1900's and now represent 65-70 percent of U.S. domestic requirements for potash fertilizers.[37] The Canadian reserves are large so there is no concern about quickly exhausting this resource. There is a concern over a major change in the ownership of the mining companies. The Province of Saskatchewan has instituted a socialist platform calling for the nationalization of large business enterprises -- this has had a negative impact on private plant expansion. Whatever the outcome of the political debate in the Province of Saskatchewan, Canada will continue to export large quantites of potash to the United States. There are just enough uncertainties to make it worthwhile to provide for the potash supply through other sources if an emergency situation should arise.

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[36] Ibid.

[37] Ibid.

3.4.3.2.4.4 Summary of Productive Capacity -- The plant capacity is available through 1980 for the production of phosphate fertilizers. New plants will be required to satisfy the growing demand for U.S. phosphate fertilizer after 1980, but this is a natural phenomenon in a growing industry. Neither raw materials nor plant capacity will hinder the production of phosphate fertilizers in the United States in the near future. Both raw material shortages and plant obsolescence create uncertainty in the nitrogen fertilizer market.

The seriousness of these problems is difficult to estimate, but they cast a cloud on a very vital product for agricultural purposes. The potash market is undergoing an institutional change which might cause temporary supply problems, but basically this market is more than able to supply the potash needs of the American farmer.

3.4.3.2.5 Fertilizer Demand Trends

In Table 3.4-23, the consumption of fertilizer in the United States is presented. The types of fertilizer used have shifted away from phosphate and potash and toward nitrogen at least on a relative basis. In 1962, nitrogen accounted for 40 percent of all fertilizers used, phosphate 33 percent, and potash 27 percent. By 1976, these changes had taken place. Nitrogen now accounts for 50 percent of all fertilizers used, phosphate 25 percent, and potash 25 percent. The nitrogen demand rose more rapidly than the phosphate or potash demand.

In Table 3.4-24, the uses of fertilizers on different crops and for different years is presented. This table suggests the dominant use of nitrogen fertilizers on corn, cotton, and wheat. Phosphate and potash were used more heavily than nitrogen only on soybeans.

The projected demand for fertilizers depends on the projected acres of land that will be cultivated, the number of acres that will be cultivated, the number of acres that will be fertilized, and the pounds of fertilizer used per acre. The acres cultivated per year swings with the farm cycle, but with rising export demand, there should be few big downturns in the acres that are cultivated. To increase the yield most of these acres will be fertilized. This, of course, will depend on the crop-fertilizer price ratio. The rate of fertilization will also depend on the crop-fertilizer price ratio. There is no reason to project a reduction in the trend of fertilizer demand (though there may be cyclical swings) and there is good reason to project a modest increase in the rate of fertilization (pounds per acre) since this can improve the yield per acre. The bottom line is that there will be a steady growth in the demand for fertilizer, and nitrogen fertilizer tends to be the dominant fertilizer for corn, cotton, and wheat. The demand trends establish targets for productive capacity--firms will generally try to fulfill their customers' needs. The growth in demand cannot be quantified exactly, but fertilizers of all types will be required to meet this demand.

3.4.3.2.6 Prices and Fertilizer Demand and Supply

The price of fertilizer will be the result of this give and take between demand and supply (productive capacity). And the price of fertilizer has a bearing on overall farm output, on food prices at the grocery store, on the U.S. trade balance, and on the general economic welfare of the country.

3.4.3.2.7 Energy Implications of the Proposed Occidental-Soviet Union Trade

The proposed Occidental-Soviet Union trade has been examined for any implications of the exchange of phosphate for ammonia, urea, and potash on the international trade position of the United States. The conclusions suggest that the trade agreement will not have either a positive or negative impact on the international trade position of the United States relative to the Soviet Union over the long run. In fact, both parties to the trade should benefit from the exchange.

As a nation the United States might find the trade objectionable if Occidental was trading away a scarce and depletable natural resource for a purely short-term gain. But, as noted in the previous section, the United States really has an abundance of phosphate rock under the most cautious calculations and a serious dwindling of natural gas reserves, the feedstock for nitrogen fertilizers. Occidental is trading away a depletable resource, but one which will not be depleted for over fifty years using the most cautious calculations and not assuming any technological improvements in mining and processing phosphate rock and assuming no new discoveries of recoverable phosphate reserves. In exchange, the United States will be receiving ammonia and urea, both of which are produced with natural gas as the feedstack. Known natural gas reserves in the United States will be depleted before the year 2000 (even before 1990) at the current rate of consumption. The trade buys the United States additional time in which to discover additional natural gas reserves or to find technologies that will allow, for example, coal to be used as the feedstack in ammonia at an acceptable cost.

Again, as a nation, the United States might find the Occidental-Soviet Union trade agreement objectionable for a short run reason, namely if there is an adverse energy tradeoff. Presently the United States is importing almost half of its crude oil[38] and is running out of domestic natural gas, at least at current consumption rates, as previously documented. The United States has an abundance of coal,[39] but is not prepared to make an immediate conversion, nor can it make the conversion in every instance. Any trade that puts additional net pressure on energy usage within the United States could be disadvantageous from the perspective of the nation. Private firms may not fully take into account the adverse pressure on the energy crisis, expecially if prices do not truly reflect the scarcity of a commodity, which is usually the case under any system of price controls. Hence, if the mining and processing of phosphate fertilizers is more energy intensive than the development and processing of nitrogen fertilizers, then the United States may find that the proposed trade affects adversely the energy crisis, at least in the short run. The question can be resolved by comparing the energy requirements to mine and process phosphate fertilizers relative to the energy requirements for mining and developing nitrogen and potash fertilizers.

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[38] Economic Report of the President (Washington, D.C., U.S. Government Printing Office, 1978), p 185.

[39] Ibid. p 192.

3.4.3.2.7.1 Energy Usage and Fertilizers -- The fertilizer industry uses a very small proportion of the total energy used in the United States.[40] Douglas and David report that almost 70 percent of the total energy consumed in the U.S. chemical fertilizer process is used in ammonia production, but the natural gas used in the ammonia production represented less than 3 percent of total natural gas consumption in the United States.[41] William White, a vice-president of the Fertilizer Institute, estimates that in 1977 energy costs represented approximately 16 percent of the total fertilizer cost in the United States.[42] This percentage has risen recently, of course, due to the rising prices of energy. The fertilizer industry spent slightly over one billion dollars for energy in 1977[43], but this is a small fraction of the total spent on energy in the United States in a given year. This statement is supported by the fact that fertilizer production used only approximately 0.8 percent of the total energy used in 1974.[44] In total, the U.S. fertilizer industry cannot match the automobile or home as a user of energy, but every industry, regardless of how small its energy consumption, will be searching for alternative sources of energy or technologies that allow their current energy usage to be more productive.

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[40] See National Energy Outlook, 1976, Federal Energy Administration (February 1976), for the various users of energy.

[41] John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), p 93.

[42] William White, "Energy and Fertilizer Supplies", Paper presented at Michigan Seed, Weed Fertilizer School (December 1977).

3.4.3.2.7.2 Energy Trade-off in Fertilizer Production -- Energy is required in producing all products, but some products require more energy than others. Similarly in producing fertilizers, some fertilizers require more energy than others and this fact is important in analyzing the measuring and significance of the proposed Occidental-Soviet Union trade for the United States. Energy tradeoffs implied by the Occidental-Soviet Union trade agreements are analyzed under the following hypothetical trade possibilities: (1) Occidental sells the ammonia, urea, and potash in the United States; (2) Occidental sells only a part of the ammonia, urea, and potash in the United States; (3) Occidental sells the ammonia, urea, and potash outside of the United States.

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[43] Ibid.

[44] In draft prepared by William C. White and Karl T. Johnson, "Energy Requirements for the Production of Phosphate Fertilizer", for the Fertilizer Institute

Case I: Occidental Sells Ammonia, etc. in United States

In the hypothetical case of Occidental selling the ammonia, urea, and potash in the United States the analysis is relatively simple. The first step is to compare the energy required in producing a common unit of phosphate, nitrogen, and potash fertilizers.

The British thermal units (BTU's) required per pound of fertilizer are as follows:[45]

Nitrogen	28,000 BTU's
Phosphate	5,000 BTU's
Potash	4,000 BTU's

Nitrogen fertilizers require 5.6 times the BTU's that phosphate fertilizers require and 7.0 times the BTU's that potash fertilizer requires. Phosphate fertilizers require 1.25 times the BTU's that potash fertilizer requires.

These requirements can also be related to the proposed trade as illustrated in Table 3.4-25. The table shows the metric tons (approximately 2,204 pounds) of urea, ammonia, potash, and phosphate that will be shipped either to the Soviet Union or to the United States. The BTU's required to produce the products are also listed. These numbers were calculated by multiplying the average number of BTU's per pound times the total pounds to be shipped. The same BTU's per pound were used for both urea and ammonia since no information was available individually.

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[45] These figures are taken from William C. White, "Energy and Fertilizer Supplies", paper presented at Michigan Seed, Weed and Fertilizer School (December 1977)

These calculations suggest that in 1979 for every BTU shipped to the Soviet Union in the form of phosphate fertilizer, the United States will receive 17.7 BTU's in the form of ammonia, potash, and urea. In 1980 for every BTU shipped to the Soviet Union in the form of phosphate fertilizer, the United States will receive 14.8 BTU's in the form of ammonia, urea, and potash. These numbers clearly suggest that the United States will be receiving the more energy intensive products and will be trading away the less energy intensive products.

A second set of estimates of energy requirements was provided by Dr. Gordon F. Palm. Dr. Palm's estimates are shown in Table 3.4-26. These data do not, however, take into account the energy used up in transporting SPA to the U.S.S.R. and ammonia, urea and potash back to the United States.

Even this comparison is not fully indicative of the significance of the trade. BTU's are a measure of the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. Different sources of energy can generate the heat and the sources of energy required for each fertilizer may be just as important as the total BTU's required. This aspect of the trade will be discussed in a forthcoming section on the possibilities of energy substitution.

It might be noted that according to Dr. Gordon Palm, the energy trade-offs shown in Table 3.4-26 represent the equivalent of a net gain over 20 years of 1.72 trillion cubic feet of gas. This is basically equivalent to the discovery of a new gas field.

Case II: Occidental Sells Only Part of the Ammonia, etc. in the United States

Occidental does not have to sell any of the ammonia, urea, or potash in the United States. Occidental has suggested that it plans to service the U.S. fertilizer market, but clearly world market conditions will dictate where Occidental finally commits the ammonia, urea, and potash. Several comments, concerning how much of the ammonia, urea, and potash must be committed to the United States in order to offset the BTU's contained in the phosphate fertilizer, can be made. These calculations will be based on the 1980 computations since these tonnages will be continued through 1997.

To offset the 11.0 trillion BTU's required in the production of 1,000,000 metric tons of phosphate fertilizers, Occidental will have to sell 178,000 metric tons of urea or ammonia in the United States, or the entire 1 million metric tons of potash plus 35,656 metric tons of urea or ammonia, or some combination of the three. The computations suggest that only about 11 percent of the ammonia or slightly over 17 percent of the urea will have to be sold in the United States in order to allow an even swap of BTU's. This again ignores the fact that different energy sources are generating the BTU's.

Case III: Occidental Sells Ammonia, etc. to Rest of the World

As previously stated, Occidental can be expected to sell the ammonia, urea, and potash to the most attractive bid on the world market so it is conceivable that none of the ammonia, urea, and potash involved in the Soviet trade will ever be used in the United States. In this case no definite trade-offs can be established.

It is known that the United States will use up 11.0 trillion BTU's in producing the phosphate fertilizer to be shipped to the Soviet Union. But it is not known what products the United States is getting in return. It is known that ultimately, though not within a one year accounting period, the United States will receive goods and/or services in return as previously illustrated. But, since the products are not known, no energy trade-off can be calculated.

3.4.3.2.7.3 Energy Substitution and the Fertilizer Industry -- Another dimension to the proposed Occidental-Soviet Union trade is the different energy used in mining and producing the different types of fertilizers. This is significant because the type of energy required and the way the energy is used have a very definite bearing on the feasibility of using alternative energy sources.

As noted previously most of the energy used in the production of ammonia and urea is used as feedstock - over 70 percent of all natural gas used in the fertilizer industry is used in this fashion. Replacing the feedstock is a difficult problem. It is not the easiest place to start if the nitrogen fertilizer companies were trying to reduce their reliance on natural gas. But, obviously, the largest payoff in terms of total reduced reliance on natural gas will come from finding an economical and environmentally acceptable feedstock.

There has already been preliminary research on the question of raw materials and the Tennessee Valley Authority (TVA) and the Energy Research and Development Administration (ERDA) have both announced plans for ammonia-from-coal projects.[46] The TVA plan would attempt to adapt existing natural gas based plants to coal based plants, while ERDA plans contemplate the construction of large new facilities. Developing efficient technology to make ammonia from coal is a high level priority in national research policy.

Ammonia can be produced from naphtha and other crude oil products, but using crude oil products as a feedstock encounters the same long-run problems as natural gas. The electrolysis of water can also provide the hydrogen necessary for the production of ammonia, but presently this method is very expensive and requires rather substantial amounts of energy. Technology is available to replace natural gas as a feedstock, but the technology is not very attractive from the point-of-view of costs.

Energy is also required to fuel the normal plant processes, but in these cases natural gas may not be used currently or, if it is, there are technologically ready alternatives. The costs may be slightly higher; there may be necessary investments for conversions; and the substitutes may not be as environmentally clean as natural gas. In summary, the importance of natural gas to the production of nitrogen fertilizers lies in the use of natural gas as a feedstock and the difficulties of replacing natural gas as the feedstock.

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[46] John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), p 93.

The energy used in producing potash in primarily determined by methods of mining, processing, and transporting potash. In this case, the source of energy is substitutable in general terms, though for a specially designed facility, substitutability of alternative energy sources may not be feasible. Data are not available on the specific energy requirements of potash production of the currently used sources of energy. Even though BTU's required per pound of potash are less than total BTU's required per pound of phosphate, the United States must import a rather large majority of its potash due to the limited potash reserves in the United States.

The production of phosphate fertilizers involves the solubilizing of phosphate ores that have been obtained from mining operations. The mining and the solubilizing takes its share of energy.

There are several steps in the mixing-processing procedure that obviously require large quantities of energy. First, phosphate rock mining begins with a dragline that removes the overburden. In Florida, approximately seven cubic yeards of material typically are handled for one cubic yard of matrix and the matrix contains only around one-third ore.[47] The obvious conclusion is that there are very large quantities of material to be handled and most of this handling is electrically powered.

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[47] See draft prepared by William C. White and Karl T. Johnson, "Energy Requirements for the Production of Phosphate Fertilizer", prepared for the Fertilizer Institute. The process of mixing and producing the phosphate fertilizer and the associated energy requirements are based on the draft by White and Johnson.

Electricity is also used to transport the matrix via water slurry to plants that may be two to five miles from the mine site. In addition, electricity is used in the beneficiation process, a matter of sizing the ore. Fuel oil is used in drying the rock. Natural gas, of course, may be used in several cases if the firms felt natural gas was a desirable substitute.

The various types of energy sources used in phosphate rock production is presented in Table 3.4-27. In Florida and North Carolina, about 90,000 BTU's per ton of phosphate rock is generated by natural gas, 367,880 BTU's per ton by fuel oil, and 170,000 BTU's per ton by electricity. Hence, natural gas accounts for around 14 percent of the total BTU's required to produce a ton of phosphate rock in Florida and North Carolina; fuel oil for almost 59 percent; and electricity for approximately 27 percent. Natural gas, the resource that is very scarce within the United States and is relatively hard to import, does not play as important a role in phosphate fertilizer as it does in nitrogen fertilizers.

Most of the energy used in producing phosphate fertilizers, however, concerns the production of sulfur and most of the sulfur used in fertilizer production comes from Frasch mining, the most energy intensive method of recovering sulfur.[48] In this process, heated water (around 325 degrees Fahrenheit) is pumped into the sulfur dome. There is a current movement to get sulfur from sour gas and refinery gases as reported by Douglas and Davis[49] and as illustrated in Table 3.4-28. The estimates suggest that sulfur produced using the Frasch method will fall from almost 65 percent of the total in 1975 to just over 49 percent of the total in 1985. This gradual reduction in the use of Frasch sulfur will reduce the energy requirements of phosphate fertilizers since it is reported that sulfur recovered from sour gas and refinery gases requires little external energy.[50] Almost 90 percent of the sulfur used in fertilizer production is used in the production of phosphate fertilizer. Hence, any energy reductions in the use of sulfur production will show up in reduced BTU's per pound of phosphate fertilizer. Indeed, it is also possible that sulfur can supply a part of the energy needs for the processing of phosphates as well.

The discussion of energy substitutes leads to one inevitable conclusion -- not only is phosphate fertilizer less energy intensive than nitrogen fertilizer, but there is a more immediate possibility of making energy substitution in the case of phosphate fertilizers than in the case of nitrogen fertilizers.

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[48] Ibid.

[49] John R. Douglas and Charles H. Davis, "Fertilizer Supply Demand", Chemical Engineering (July 18, 1977), p 94.

[50] Charles H. Davis, "Energy Requirements for Alternative Methods for Processing Phosphate Fertilizers", ISMA Conference (1974).

3.4.3.2.7.4 Energy Curtailments -- A potential problem to any user of natural gas at this point in time is the possibility of natural gas curtailment. Price controls on interstate natural gas have created an imbalance between the quantity demanded and the quantity supplied. In order to determine who will receive the available natural gas the government has devised a priority list with homes and hospitals having a first priority and farm related goods such as fertilizers having a second priority. A long, cold winter, however, can easily cause curtailments even among the first priorities.

Curtailments in natural gas have occurred in the last several years--curtailments affecting nitrogen fertilizers in particular, but also modestly affecting phosphate fertilizers. Douglas and Davis estimated that during 1975-76 close to 0.75 million tons of ammonia production was lost due to natural gas curtailments.[51] White suggests the following ammonia losses during the 1970's[52]:

1970	113,000 tons
1971	164,000 tons
1972	188,000 tons
1973	315,000 tons
1974	231,000 tons
1975	356,000 tons
1976	251,000 tons
1977	730,000 tons

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[51] John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), p 91.

[52] William C. White, "Energy and Fertilizer Supplies", Paper presented to Michigan Seed, Weed and Fertilizer School, Lansing, MI, (December 1977).

These curtailments have been getting worse gradually and there is little hope for any improvement in the immediate future, at least from domestic sources. Importing ammonia is, by far, the surest method of overcoming natural gas curtailments.

Natural gas curtailments will undoubtedly have the most severe impact on nitrogen fertilizers since natural gas serves as a feedstock for these fertilizers. However, phosphate fertilizers have also been struck by natural gas curtailments. In 1973, according to the Florida Phosphate Council, phosphate producers experienced 319 natural gas curtailments leading to a loss production of around a million tons of phosphate rock.[53]

3.4.3.3 Overview and Summary

There are several conclusions of this section that should be summarized. International trade in general should lead to benefits for both of the trading partners. In this particular case, Occidental is giving up phosphate rock plus the use of its capital equipment and the use of its employees, but in return, Occidental will be receiving ammonia, urea, and potash. The United States will definitely give up its phosphate, and will probably receive the ammonia, urea, and potash, depending upon where Occidental markets the commodities. But sooner or later, the United States will receive goods and/or services from a foreign country.

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[53] Reported in Ibid.

This particular trade seems especially advantageous to the United States for several reasons. First, the United States is giving up a relatively abundant resource, phosphate, in exchange for commodities made from a relatively scare domestic resource. Second, the energy requirements for producing phosphate fertilizer are significantly less than the energy requirements for producing ammonia or urea. Finally, there may be disruptions in the domestic production of ammonia and urea due to natural gas curtailments. Importing ammonia and urea will be the least expensive method of overcoming such disruptions.

The trade buys time for all nitrogen fertilizer producers to develop a feasible alternative feedstock. Energy substitutes in phosphate fertilizers appear to be technologically and economically feasible at this time and much has already been done in terms of altering the method of obtaining sulfur. Alternative feedstock materials for ammonia appear to be technologically more complicated.

Without regard to any local (three-county area) environmental damage, the trade seems to stack up as a beneficial deal for the United States.

3.4.4 EFFECTS OF SOCIOECONOMIC IMPACTS ON BASELINE PROJECTIONS

The baseline projections of all socioeconomic variables were presented in Section 2.8. The socioeconomic impact of Occidental's planned expansion were presented earlier in this section. Also in this section, baseline projections for 1985, 1990, 1995 and 2000 are modified to take into account the impact of the expansion plan. Again, it should be remembered that the projected impact on the total population of Florida is insignificant although the impacts on income and employment are not. Table 3.4-29 contains a summary of projections for selected socio-economic variables for the State of Florida both with and without the impacts of Occidental's expansion plan taken into account. Clearly, from these data the impacts of Occidental's expansion plans, while fairly large in absolute numbers, are likely to be small in relation to the state-wide magnitudes of those variables. No measureable impacts are expected at the state level in population or labor force. The effects on earnings, employment, and taxes are expected to be substantial but to represent small percentages of the state totals. For example, by 2000 it is expected that state-wide total earned income will be $73 million (in 1974 dollars) more than it would be in the absence of Occidental's expansion program. Yet this amounts to less than 0.1 percent of total earned income in the state that year. Similarly, while per capita earned income will also be affected positively by Occidental's expansion program, it is expected to also be up by less than 0.1 percent as a result of the expansion plan.

The relative impact within the three-county area of immediate impact will, of course, be much larger. These comparisons are summarized in Tables 3.4-30 and 31. By 2000 the local area population is expected to be up by 4.3 percent over what it would otherwise be, the labor force is expected to be up by about 3.6 percent more than it would otherwise be, and employment is expected to be about 4.6 percent more than it would be without the expansion. At the same time, earned income is expected to be 6.7 percent more than it would otherwise be and per capita income will be about 2.3 percent more than it would otherwise be.

There are expected to be about 6.1 percent more occupied housing units than there would be without the expansion but residential land use is not likely to be that much greater since it may be assumed that new residences will be more densely settled than the average of the older ones. Thus, residential land use in the three counties will most likely not be more than about 2 to 3 percent more than the baseline projections.

According to Table 3.4-31, school enrollment in 2000 will probably be some 3.6 percent more than would be the case without the expansion. Assuming that school costs per student will be the same with or without the expansion, total public school costs will also be about 3.6 percent more than they would be in the absence of the expansion. Similarly, assuming that other local government expenditures per person will be the same with or without the expansion, it could be expected that these would be about 3.6 percent more as a result of the expansion. This should be viewed as a maximum estimate since the per capita costs are likely to be less for the added enrollments.

3.4.5 SUMMARY OF SOCIOECONOMIC FACTORS

The detailed estimates of socioeconomic impacts of Occidental's planned expansions have already been presented earlier in this section. It is clear that, on balance, the socioeconomic effects on the area will be positive. There will be rather substantial increases in income, both in the State of Florida and in the three-county impact area. At the same time employment will also increase substantially, though not as much as income; so income per worker will increase as a result of the new expansion.

While employment is expected to increase by a relatively large amount there is not likely to be a very large increase in the labor force or population. For the state as a whole, it is expected that the main effect will be to absorb existing unemployment and perhaps put some people to work who are not now even in the labor force, although they do live in Florida. It is expected that there will be a moderate increase in the labor force and population of the three counties as a result of movements there from other places in Florida (or a reduction in the movement of young people who now live there to other places) to take advantage of the increased employment opportunities. Thus, the main socioeconomic effect of the expansion for Florida as a whole will be to increase total and per capita income, while reducing unemployment and government expenditures for unemployment compensation.

For the three counties, the effect will also be to increase employment and population, increase the need for housing and residential land use, increase the demand for government services and government expenditures, as well as government revenues. While there are both positive and negative impacts involved, insofar as the well-being of the citizens are concerned, it seems clear that on balance the impacts will be far more beneficial than harmful.

In addition to the impacts of the proposed expansions on the three counties and the state, section 3.4.3 concerned itself with the national effects of the export of SPA to the Soviet Union and the related purchases from the Soviet Union of ammonia and potash. From that analysis, it is clear that such trade will be a net benefit to the United States in terms of the balance of trade, the trading of relatively more abundant natural resources for those that are more scarce, and in terms of the net energy balance resulting from the trade. That is, the energy required to produce the SPA and ship it to the Soviet Union is far less than the energy that would be required to produce the ammonia domestically.

The U.S. Department of Commerce has evaluated the terms of the agreement between the U.S.S.R. and Occidental and has approved the plan. In addition the complete contract is on file with the Securities and Exchange Commission.

Table 3.4-1 Employment by Occidental Chemical by County Where Employee Lives for 1974-1977.

County	1974	1975	1976	1977
Columbia	335	402	407	463
Hamilton	355	498	448	435
Suwannee	223	365	258	228
Other*	119	98	133	59
Total	1,032	1,363	1,246	1,185

Source: Occidental Chemical Company.

Note: Figures for table are as of December 31, except 1977 when it is as of September.

*Including Georgia.

Table 3.4-2 Occidental Chemical Company Payrolls 1973-1976, and Projected 1978-1980.

Year	Payroll
1973	$ 7,034,799
1974	9,972,485
1975	18,303,495
1976	17,822,593
1978	19,099,142
1979	23,186,544
1980	31,508,000

Source: Data for 1973-1976 from Occidental Chemical Co. Data for 1978. 1979 and 1980 are projections based on projected employment and projected average salary and wage levels.

Table 3.4-3 Total Occidental Income Impacts, 1976-1980.

Year	Total Impact	Dollar Change	Percent Change
1976	$ 54,507,410	-	-
1978	59,491,333	4,983,923	9.1
1979	74,764,534	15,273,201	25.7
1980	100,064,830	25,300,297	33.8

Table 3.4-4 Projected Real 1974 Dollar and Current Dollar Income and Earnings, 1974 and 1980, ($ Millions)

	1974	1980 1974 (Dollars)	1980 1980 (Dollars)
Florida			
Total Personal Income	43,808	60,404	88,138
Earned Income	30,625	42,227	61,615
Local Impact Area			
Total Personal Income	228	298	434
Earned Income	183	239	349
Columbia County			
Total Personal Income	116	150	219
Earned Income	92	119	174
Hamilton County			
Total Personal Income	42	55	80
Earned Income	37	48	70
Suwannee County			
Total Personal Income	70	93	136
Earned Income	54	72	105

Table 3.4-5 Short-term income impacts of Occidental construction.

Phase	Florida Statewide Impacts	Three-County Impacts
Phase I		
Direct	$ 30,170,000	$11,560,500
Indirect	14,119,560	2,502,940
Induced	29,799,340	6,569,667
Total	$ 74,088,900	$20,633,107
Phase II		
Direct	$ 58,730,000	$26,050,500
Indirect	27,485,640	5,640,140
Induced	58,008,460	14,804,127
Total	$144,224,100	$46,494,767
Total		
Direct	$ 88,900,000	$37,611,000
Indirect	41,605,200	8,143,080
Induced	87,807,800	21,373,794
Total	$218,313,000	$67,127,874

Table 3.4-6 The Marginal Impact of Occidental's Expansion Plans On Employment

	1976	1978	1979	1980
Florida Employment Impact	4087	3687	4176	5324
Change (Number)	-	-400	489	1148
Change (Percent)	-	-9.8	+13.3	+27.5
Three County Employment Impact	2190	1898	2229	2853
Change (Number)	-	-292	331	624
Change (Percent)	-	-13.3	+17.4	+28.0

Table 3.4-7 Short-term employment resulting from Occidental's construction program.

	Florida Total	Three-County Area
Phase I		
Direct Impact	1,897	1,615
Indirect Impact	887	157
Induced Impact	1,873	413
Total	4,657	2,185
Phase II		
Direct Impact	3,419	3,370
Indirect Impact	1,600	328
Induced Impact	3,377	862
Total	8,396	4,560
Total--Both Phases		
Direct Impact	5,316	4,985
Indirect Impact	2,487	485
Induced Impact	5,250	1,275
Total	13,053	6,745

Table 3.4-8 Employment, Labor Force, and Population Impacts of Occidental's Expansion Plans

	1979	1980
Projected Employment		
Without Expansions	23,443	24,186
With Expansions	23,774	25,455
Expansion Impact	331	955
Unemployment Rate		
Without Expansion	5.0%	5.0%
With Expansion	4.0%	3.5%
Projected Labor Force		
Without Expansion	24,677	25,459
With Expansion	24,765	26,378
Expansion Impact	88	919
Labor Force Participation Rate		
Without Expansion	39.8%	40.1%
With Expansion	39.8%	39.8%
Projected Population		
Without Expansion	61,964	63,500
With Expansion	62,228	66,257
Expansion Impact	264	2,757

Table 3.4-9 Population and Housing Needs Impact Projections

	1979	1980
Total Projected Population		
Without Expansion	61,954	63,500
With Expansion	62,228	66,257
Occidental Impact	264	2,757
Projected Housing Unit Needs		
Without Expansion	23,564	24,351
With Expansion	23,652	25,270
Occidental Impact	88	919
Population Per Household		
Without Expansion	2.63	2.61
With Expansion	2.63	2.62

Table 3.4-10 Population and Public School Enrollments, 1975 and 1980

	1975	1980
Population		
Columbia	28,664	31,600
Hamilton	8,600	9,600
Suwannee	18,918	22,300
School Enrollment		
Columbia	6,267	6,890
Hamilton	1,941	2,104
Suwannee	4,317	4,959
Enrollment/Population		
Columbia	.2186	.2180
Hamilton	.2270	.2192
Suwannee	.2270	.2224
Three County Total	.2229	.2197

Table 3.4-11 Population and School Enrollment in the Impact Area, 1980 With and Without Occidental's Expansion

	1979	1980
Population		
With Expansion	62,228	66,257
Without Expansion	61,964	63,500
Occidental Impact	264	2,757
Percent of Baseline	0.4	4.3
School Enrollments		
With Expansion	13,692	14,642
Without Expansion	13,626	13,953
Occidental Impact	66	689
Percent of Baseline	0.5	4.9
Enrollment/Population		
With Expansion	.2200	.2210
Without Expansion	.2199	.2197

Table 3.4-12 Projected Cost of Local Government Services*, Three County Total (Thousands of 1974 Dollars)

	1974	1980
Total Population		
Without Occidental Expansion	54,233	63,500
With Occidental Expansion	-	66,257
Occidental Impact	-	2,757
Total Cost of Public Services		
Without Occidental Expansion	7,451	8,805
With Occidental Expansion	-	9,063
Occidental Impact	-	258
Per Capita Costs		
Without Occidental Expansion	$137.39	$138.66
With Occidental Expansion	-	$136.79

* Includes all local government services except public education in Columbia, Hamilton, and Suwannee Counties.

Table 3.4-13 U.S. consumption of fertilizers (thousands of short tons).

Year	Nitrogen	Phosphates	Potash
1962	3,370	2,788	2,271
1963	3,929	3,052	2,503
1964	4,353	3,361	2,730
1965	4,639	3,499	2,835
1966	5,326	3,882	3,221
1967	6,027	4,305	3,642
1968	6,788	4,453	3,793
1969	6,958	4,659	3,892
1970	7,459	4,569	4,036
1971	8,134	4,803	4,231
1972	8,016	4,873	4,332
1973	8,295	5,085	4,622
1974	9,157	5,099	5,083
1975	8,608	4,511	4,453
1976	10,345	5,215	5,208

Source: U.S. Department of Agriculture, "Fertilizer Consumption," annual reports. In John R. Douglas and Charles H. Davis, "Fertilizer Supply and Demand," Chemical Engineering (July 18, 1977), p. 90.

Table 3.4-14 Production of Nitrogen Fertilizer Materials In United States (Thousands of Short Tons)

Year	Anhydrous Ammonia	Synthetic Materials	Other Nitrogen Materials[a]
1962	5,809	1,697	2,305
1963	6,692	1,823	2,705
1964	7,634	2,306	3,076
1965	8,869	2,656	3,208
1966	10,604	2,859	3,657
1967	12,194	2,824	4,337
1968	12,119	2,723	3,916
1969	12,768	2,563	4,440
1970	13,824	2,489	4,887
1971	14,537	2,359	4,827
1972	15,169	2,419	5,128
1973	15,208	2,587	5,749
1974	15,732	2,657	5,796
1975	16,393	2,595	5,675

Source: U.S. Department of Commerce, "Inorganic Chemicals, Series M28A, Annual Reports." Published in Fertilizer Trends, 1976, by TVA's National Fertilizer Development Center.

[a] Includes ammonium sulfate, nitrogen solutions, solutions, solid urea, and nitrogen content of ammonium phosphates.

Table 3.4-15 Production of phosphate rock in the United States for 1962-1975 (thousands of short tons).

Year	Florida and North Carolina	U.S. Total	Year-end Producer Stocks
1962	15,623	21,708	5,145
1963	16,343	22,238	5,140
1964	19,161	25,715	6,123
1965	21,563	29,482	6,514
1966	29,827	39,044	10,118
1967	31,910	39,700	9,942
1968	33,032	41,251	13,943
1969	29,930	37,725	13,697
1970	31,278	38,739	14,566
1971	32,151	38,886	12,617
1972	34,121	40,831	10,501
1973	34,427	42,137	8,446
1974	36,980	45,686	6,975
1975	40,699	48,816	9,946

Source: U.S. Bureau of Mines, "Phosphate Rock," Mineral Yearbook, annual reports. Reprinted in Fertilizer Trends, 1976, published by the TVA National Fertilizer Development Center.

Table 3.4-16 Potash production in the United States and Canada for 1962-1975 (thousands of tons)

Year	United States	Canada
1962	2,452	n.a.
1963	2,864	404
1964	3,897	747
1965	3,140	1,176
1966	3,320	1,928
1967	3,299	2,204
1968	2,722	2,971
1969	2,804	3,086
1970	2,729	3,931
1971	2,587	3,422
1972	2,659	4,151
1973	2,603	3,995
1974	2,552	5,377
1975	2,501	5,582

Source: U.S. Bureau of Mines, "Potash," Minerals Yearbook, annual reports and Statistics Canada, Fertilizer Trade, annual reports. Reprinted in Fertilizer Trends, 1976, published by the TVA National Fertilizer Development Center.

Table 3.4-17 Exports and imports of the United States for nitrogen fertilizer materials, phosphate fertilizers, and potash for 1962-1975 (thousands of tons).

Year	Nitrogen Fertilizer Materials		Phosphate Fertilizers		Potash	
	Exports	Imports	Exports	Imports	Exports	Imports
1962	233	376	307	71	506	341
1963	216	399	369	58	425	594
1964	324	353	474	43	618	737
1965	450	528	390	76	648	1,108
1966	701	549	650	79	621	1,491
1967	822	668	862	93	649	1,697
1968	1,376	642	1,108	107	735	2,166
1969	1,522	706	708	120	700	2,332
1970	1,304	879	800	200	544	2,605
1971	907	868	977	202	564	2,766
1972	1,234	890	1,263	221	764	2,961
1973	1,430	885	1,473	173	889	3,587
1974	926	973	1,451	152	787	4,326
1975	1,100	1,225	1,882	133	769	3,736

Source: U.S. Department of Commerce, U.S. Exports (Report FT 410); U.S. Department of Commerce, U.S. Imports (Report FT 135); reprinted in Fertilizer Trends, 1976 published by TVA's National Fertilizer Development Center.

Table 3.4-18 Estimated total deliveries of phosphate rock by production region (million metric tons).

Area	1965	1970	1973	1975
United States	26.5	33.3	40.4	41.8
Africa, Near East	16.7	21.0	29.6	26.7
USSR and Eastern Europe	15.0	18.0	21.3	24.5
Other Asia	1.9	2.5	4.0	5.5
Pacific Islands	3.0	3.7	4.6	3.4
Others	0.3	0.5	0.6	1.0
Total	63.4	79.0	100.4	102.8

Source: Douglas and Harre, "Patterns of Phosphate Rock Production and Use," paper presented to National Research Council TVA Symposium (February 24-25, 1977).

Table 3.4-19 World phosphate rock production, 1975, and Capacity, 1975, 1976, and 1980 (Millions of Short Tons)

Area	Production in 1975	Capacity		
		1975	1976	1980
North America				
United States	48.8	50.0	56.0	65.0
Other	.4	.4	.3	.4
South America	.6	.6	.6	2.0
Europe				
U.S.S.R.	26.6	27.0	27.0	36.0
Other	.1	.2	.2	.2
Africa				
Morocco	14.9	21.0	21.0	24.0
Other	13.4	19.2	19.8	23.0
Asia	11.3	11.6	11.6	17.6
Oceania	2.4	3.4	3.4	3.2
Total	118.6	133.4	139.9	171.3

Source: William F. Stowasser, "Phosphate--1977," U.S. Department of Interior, Bureau of Mines, 1977.

Table 3.4-20 Identified World Phosphate Resources (Millions of Short Tons)

Area	Reserves	Identified Subeconomic Resources	Total Identified Resources
North America			
United States	3,220	1,660	4,880
Other	2	2	4
South America	80	420	500
Europe			
Russia	800	3,200	4,000
Other	30	70	100
Africa			
Morocco	18,000	40,000	58,000
Other	4,080	3,920	8,000
Asia	460	2,930	3,390
Oceania	1,120	2,030	3,150
Total	27,792	54,232	82,024

Source: William F. Stowasser, "Phosphate-1977," U.S. Department of Interior, Bureau of Mines, 1977.

Table 3.4-21 Identified Phosphate Resources in the United States (Millions of Short Tons)

Area	Measured Reserves	Identified Subeconomic Resources	Total Identified Resources
Florida	1,200	760	1,960
North Carolina	1,000	200	1,200
Tennessee	20	--	20
Idaho	800	500	1,300
Utah	100	100	200
Wyoming	50	50	100
Montana	50	50	100
Total	3,200	1,660	4,880

Source: William F. Stowasser, "Phosphate-1977," U.S. Department of Interior, Bureau of Mines, 1977.

Table 3.4-22 Projected Ammonia Capacity Through 1980 (Thousands of Short Tons per Year).

Year	Actual Capacity or Projected Capacity
1975	18,529
1976	18,862
1977	21,768
1978	23,156
1979	24,107
1980	24,107

Source: Douglas and Davis, "Fertilizer Supply and Demand," Chemical Engineering (July 18, 1977).

Table 3.4-23 United States Consumption of Fertilizers (Thousands of Short Tons)

Year	Nitrogen	Phosphate	Potash
1962	3,370	2,788	2,271
1965	4,639	3,499	2,835
1968	6,788	4,453	3,793
1970	7,459	4,569	4,036
1972	8,016	4,873	4,332
1974	9,157	5,099	5,083
1975	8,608	4,511	4,453
1976	10,345	5,215	5,208

Source: U.S. Department of Agriculture, "Fertilizer Consumption," Annual Reports. In John R. Douglas, and Charles H. Davis, "Fertilizer Supply and Demand," Chemical Engineering (July 18, 1977), p. 90.

Table 3.4-24 Fertilizers Used on Harvested Acres of Corn for Grain, Cotton, Soybeans for Beans, and All Wheat for the United States for 1972 and 1976

Crop and Year	Acre Receiving				Rates Per Acre Receiving			Total Harvested Acre (1,000 Acres)
	Any (%)	Nitrogen (%)	Phosphate (%)	Potash (%)	Nitrogen (lb)	Phosphate (lb)	Potash (lb)	
Corn								
1972	96	96	90	86	115	68	69	57,421
1976	97	97	90	84	127	67	78	70,955
Cotton								
1972	77	77	55	41	75	55	61	12,984
1976	76	75	53	37	81	52	56	10,914
Soybean								
1972	31	22	29	31	14	42	51	45,698
1976	31	20	28	30	14	42	60	49,401
Wheat								
1972	63	62	44	15	46	37	38	47,284
1976	71	71	50	21	51	37	37	70,824

Source: Fertilizer Situation 1977, Economic Research Service, U.S. Department of Agriculture (January, 1977).

Table 3.4-25 Energy Requirements Implied by Occidental-Soviet Union Trade

Product	1978	1979	1980
Urea			
Metric Tons Shipped	250.0	250.0	1,000.0
BTU's in trillions	15.4	15.4	61.7
Ammonia			
Metric Tons Shipped	600.0	1,150.0	1,500.0*
BTU's in trillions	37.0	70.9	92.6
Potash			
Metric Tons Shipped	380.0	830.0	1,000.0
BTU's in trillions	3.3	7.3	8.8
Phosphate			
Metric Tons Shipped	10.0	480.0	1,000.0
BTU's in trillions	0.1	5.3	11.0

* excluding the 0.6 million metric tons to be shipped to the United States as part of the agreement for Occidental's assistance in constructing port facilities.

Table 3.4-26 Estimated BTU's Required to Produce Anhydrous Ammonia, Urea, Potash and SPA

	Trade	Energy To Produce BTU/MT	BTU/Year
Anhydrous Ammonia*	1,500,000	43.50×10^6	65.26×10^{12}
Urea	1,000,000	30.72×10^6	20.72×10^{12}
Potash	1,000,000	1.53×10^6	1.53×10^{12}
Superphosphoric Acid**	700,000	16.13×10^6	11.29×10^{12}

* Does not include 0.6 million metric tons to be shipped over a 10-year period to provide U.S.S.R. with foreign exchange to pay for Russian port and plant facilities.

** 700,000 MTPY P_2O_5 as 70% SPA shipped. Equivalent to 1,000,000 metric tons of superphosphoric acid (SPA) per year.

Source: Personal correspondence from Dr. Gordon Palm, May 2, 1978.

Table 3.4-27 Energy Use in Phosphate Rock Production in United States (Unit Per Ton of Rock)

Energy Source	Region Florida, North Carolina	 Tennessee	 Western States
Coal (lbs)	-	100.00	4.00
Fuel Oil (gal)	2.52	0.42	8.00
Natural Gas (cu. ft.)	90.00	135.00	120.00
Electricity (kilowatt/hr)	50.00	35.00	20.00
Million BTU (per ton)	0.62	1.58	0.37

Table 3.4-28 Supply Pattern for Sulfur in the United States (Long Tons Sulfur Equivalent)

	Estimated Production			
Source of Sulfur	1975	% of Total	1985	% of Total
Frasch	7.8	63.9	8.2	43.2
Recovered				
Refinery	1.7	13.9	4.0	21.0
Sour Gas	1.2	9.8	3.5	18.4
By-Product Acid				
Nonferrous smelters	1.0	8.2	2.0	10.5
Stack-gas cleanup	-	0.0	0.6	3.2
Pyrites-based Acid	0.4	3.3	0.5	2.6
Other	0.1	0.9	0.2	1.1
TOTAL	12.2	100.0	19.0	100.0

Source: John R. Dougals and Charles H. Davis, "Fertilizer Supply and Demand", Chemical Engineering (July 18, 1977), p. 94.

Table 3.4-29 Projections of Florida's Population, Employment, Earned Income and Other Variables With and Without Occidental's Expansion

	Year			
	1980	1985	1990	2000
Florida				
Population (thousands)	9,878	11,218	12,410	14,545
Labor Force (thousands)	4,050	4,599	5,080	5,968
Employment (Thousands)				
Without Expansion	3,847	4,369	4,834	5,665
With Expansion	3,849	4,371	4,836	5,668
Earned Income (millions of 1974 dollars)				
Without Expansion	$42,227	$55,451	$70,771	$110,962
With Expansion	42,255	55,488	70,818	111,035
Earned Income Per Capita (1974 dollars)				
Without Expansion	$4,275	$4,943	$5,703	$7,629
With Expansion	4,278	4,946	5,707	7,634
Sales Tax Collections (millions of 1974 dollars)				
Without Expansion	$2,190	$2,724	$3,476	$5,450
With Expansion	2,192	2,727	3,479	5,455

Table 3.4-30 Projections of Population, Labor Force, Employment, Earned Income and Other Socio-Economic Variables For The Three County Area With and Without Occidental's Expansion

	Year			
	1980	1985	1990	2000
Population				
Without Expansion	63,500	69,600	74,200	82,000
With Expansion	66,257	72,513	77,288	85,506
Civilian Labor Force				
Without Expansion	25,459	27,912	29,768	32,912
With Expansion	26,387	28,886	30,800	34,088
Employment				
Without Expansion	24,186	26,517	28,280	31,267
With Expansion	25,455	27,837	29,650	32,714
Percent Unemployed				
Without Expansion	5.0	5.0	5.0	5.0
With Expansion	3.5	3.6	3.7	4.0
Total Earned Income (in millions of 1974 dollars)				
Without Expansion	$239.0	$302.0	$372.8	$559.2
With Expansion	254.9	322.1	397.6	596.4
Per Capita Earned Income (in 1974 dollars)				
Without Expansion	$3,764	$4,339	$5,024	$6,820
With Expansion	3,847	4,441	5,144	6,975
Housing Units				
Without Expansion	24,351	25,707	26,431	29,211
With Expansion	25,270	26,637	28,072	31,001

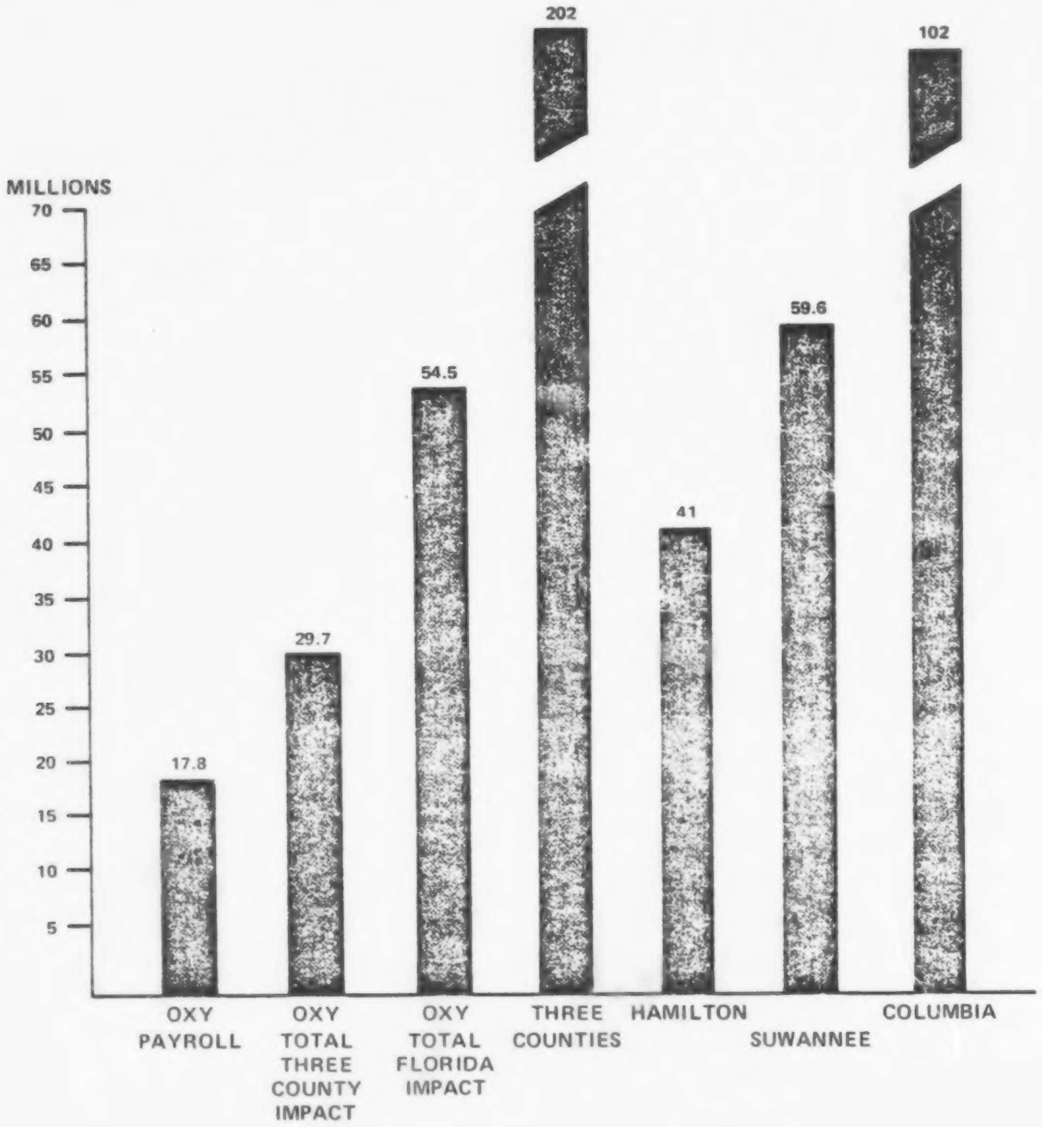
Table 3.4-31 Projected School Enrollments, Public Service Costs, and Revenues, With and Without Occidental's Expansion (Within local impact area)

	Year			
	1980	1985	1990	2000
School Enrollment				
Without Expansion	13,953	15,460	16,913	18,508
With Expansion	14,642	16,199	17,515	19,183
School Expenditures (Thousands of 1974 dollars)				
Without Expansion	$23,416	$25,640	$27,567	$30,167
With Expansion	24,572	26,865	28,548	31,267
Local Government Expanditures (Thousands of 1974 dollars)				
Without Expansion	$ 8,805	$ 9,660	10,284	$11,322
With Expansion	9,063	9,929	10,697	11,909

Selling Industries	Purchasing Industry					Final Demand				Total
	1	2	3	. . .	n	1	2	. . .	m	
1	X_{11}	X_{12}	X_{13}	. . .	X_{1n}	f_{11}	f_{12}	. . .	f_{1m}	X_1
2	X_{21}	X_{22}	X_{23}	. . .	X_{2n}	f_{21}	f_{22}	. . .	f_{2m}	X_2
3	X_{31}	X_{32}	X_{33}	. . .	X_{3n}	f_{31}	f_{32}	. . .	f_{3m}	X_3
.	.	.	.			.	.	.		
.	.	.	.			.	.	.		
.	.	.	.			.	.	.		
n	X_{n1}	X_{n2}	X_{n3}	. . .	X_{nn}	f_{n1}	f_{n2}	. . .	f_{nm}	X_n
Final Demand	h_1	h_2	h_3	. . .	h_n	h_{n+1}				
	I_1	I_2	I_3	. . .	I_n	I_{n+1}				
	O_1	O_2	O_3	. . .	O_n	O_{n+1}				
Total	X_1	X_2	X_3	. . .	X_n	X_{n+1}				X

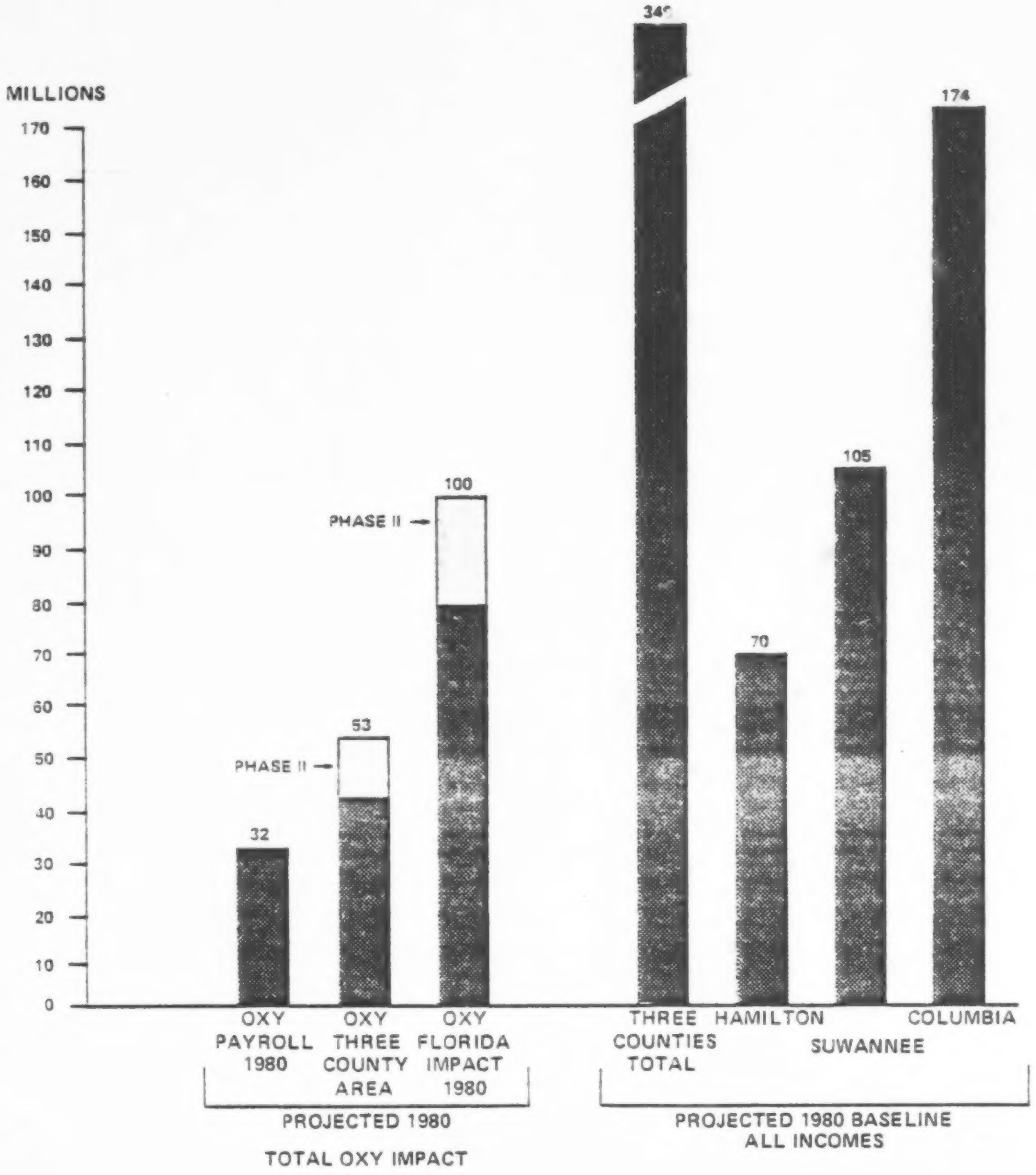
CONCEPT OF INPUT–OUTPUT MULTIPLIERS–STATE OF FLORIDA

FIGURE 3.4-1



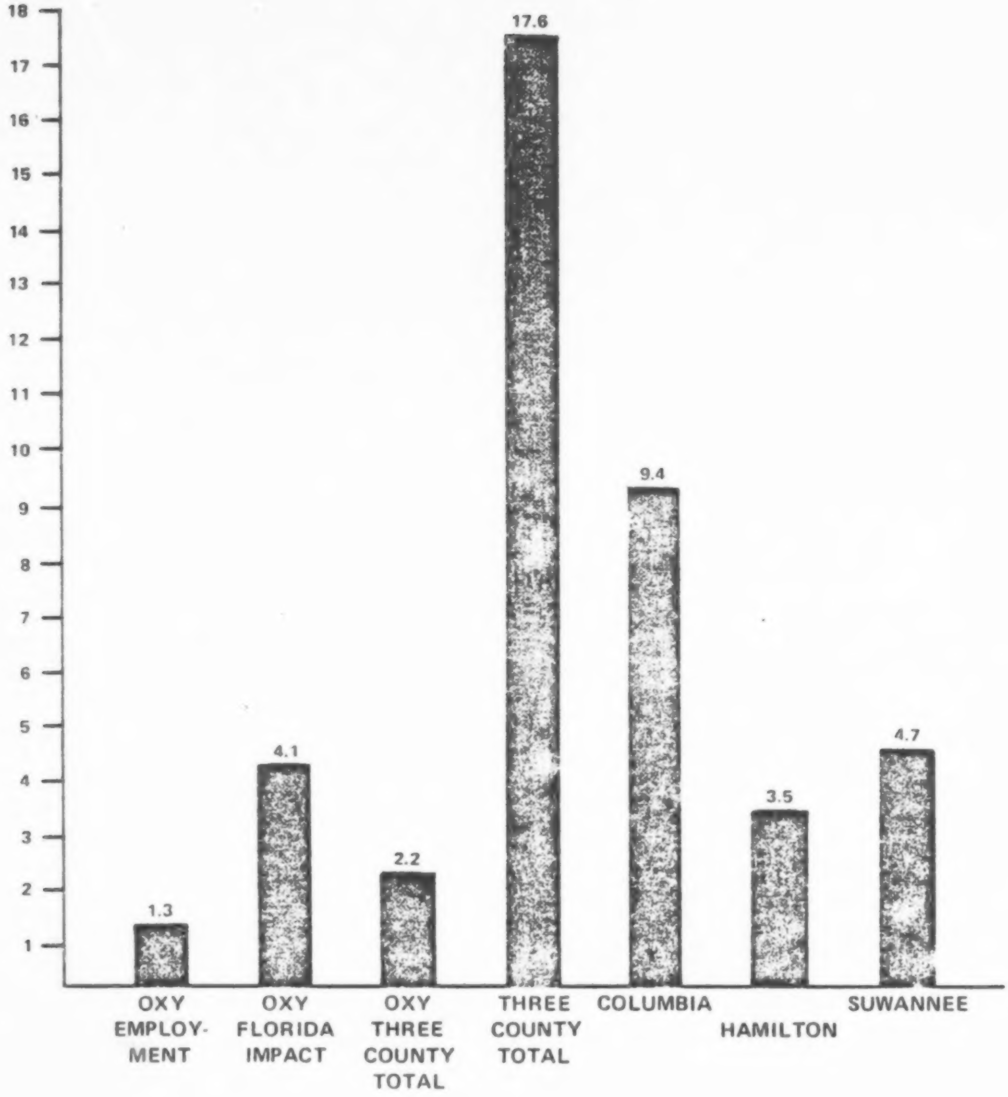
OCCIDENTAL'S TOTAL INCOME IMPACT AS COMPARED TO ESTIMATED LABOR AND PROPIETOR'S INCOME IN THE IMMEDIATE AREA, 1976

FIGURE 3.4-2



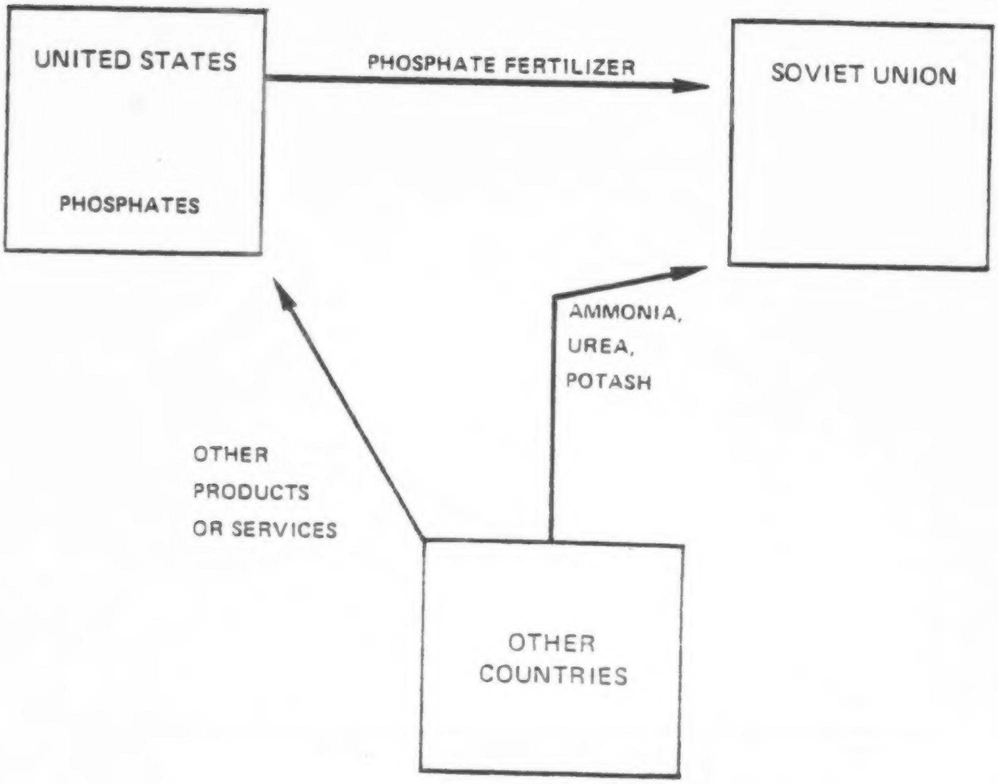
OCCIDENTAL'S TOTAL INCOME IMPACT AS COMPARED TO ESTIMATED LABOR AND PROPRIETOR'S INCOME IN THE IMMEDIATE IMPACT AREA, 1980

FIGURE 3.4-3



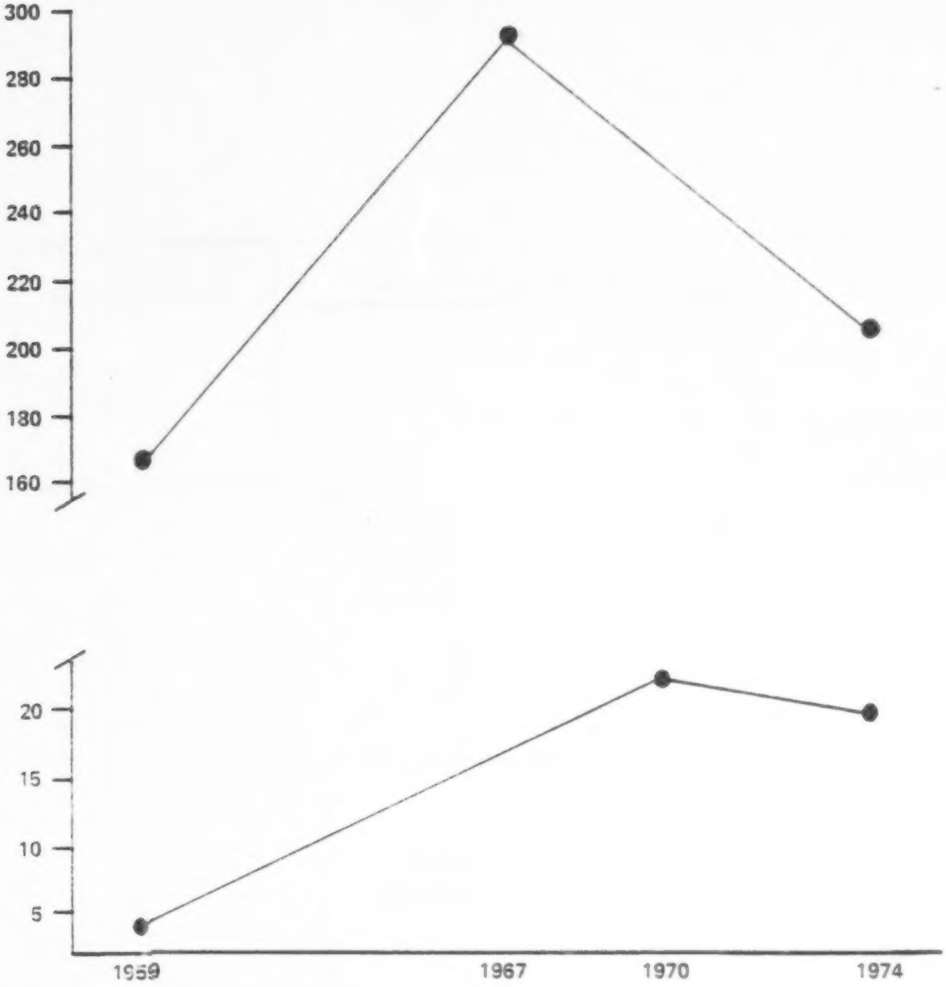
OCCIDENTAL'S EMPLOYMENT IMPACT AND ESTIMATED TOTAL NONAGRICULTURAL EMPLOYMENT COVERED BY EMPLOYMENT SECURITY 1976

FIGURE 3.4-4


UNITED STATES
PHOSPHATES
PHOSPHATE FERTILIZER
SOVIET UNION
AMMONIA,
UREA,
POTASH
OTHER
PRODUCTS
OR SERVICES
OTHER
COUNTRIES

FLOWCHART OF INTERNATIONAL TRADE

FIGURE 3.4-5

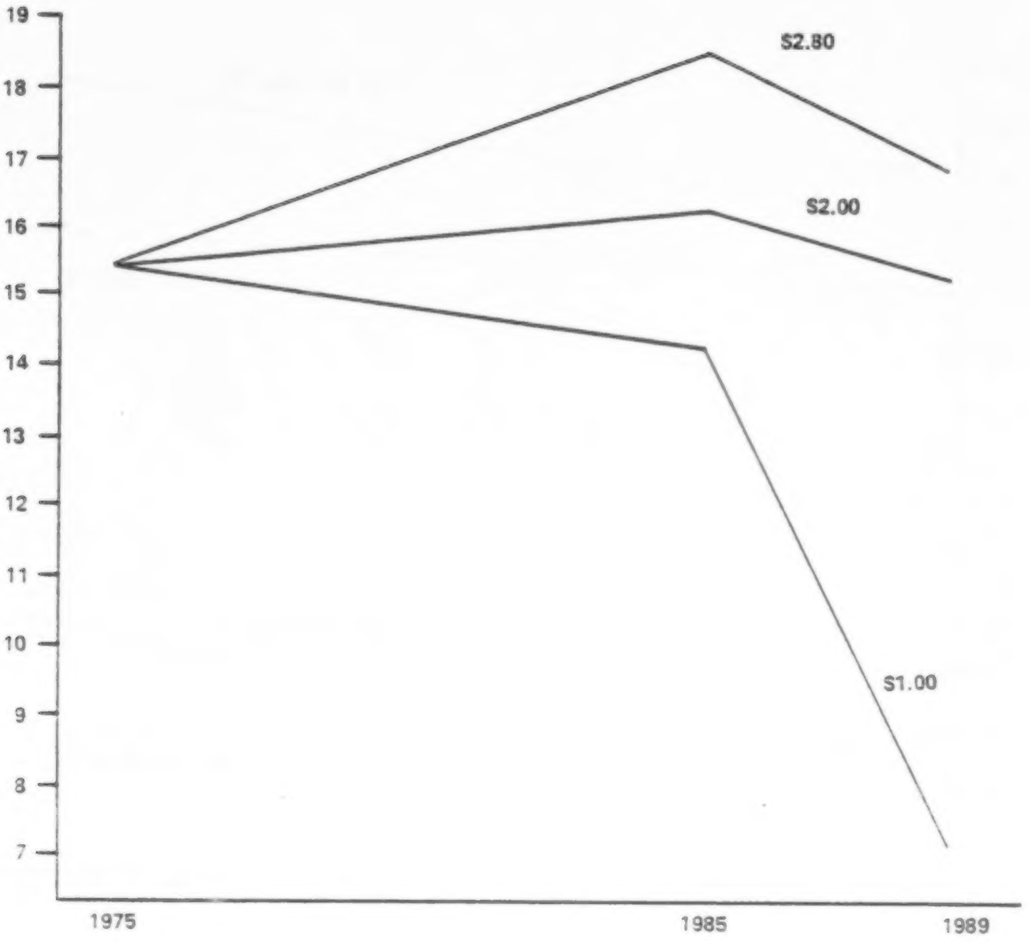


NOTE: THE POSITION OF THE POINTS ARE APPROXIMATELY CORRECT AS PRESENTED IN THE ORIGINAL SOURCE. THE REMAINING PARTS OF THE GRAPH ARE INDICATIVE OF TREND ONLY.

SOURCE: NATIONAL ENERGY OUTLOOK, 1976, FEDERAL ENERGY ADMINISTRATION (FEBRUARY 1976).

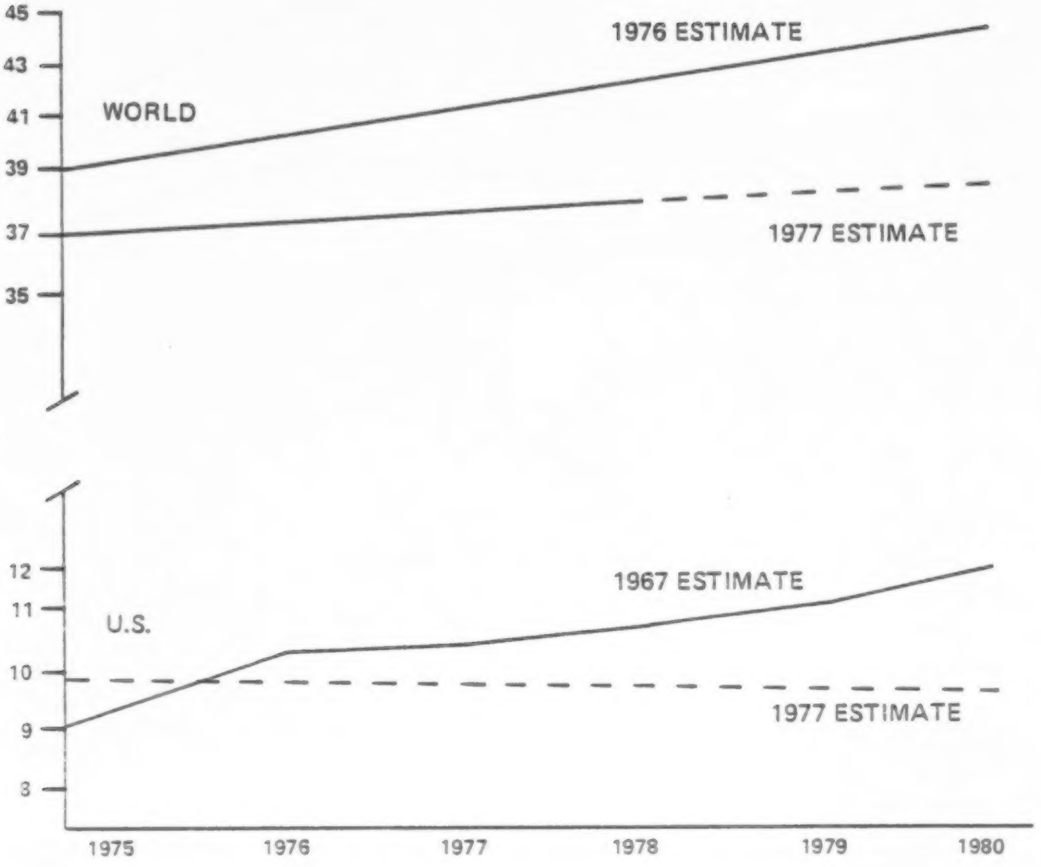
NATURAL GAS PRODUCTION AND RESERVES IN THE UNITED STATES, EXCLUDING ALASKA

FIGURE 3.4-6



PROJECTIONS OF NATURAL GAS PRODUCTION AT ALTERNATIVE PRICES IN UNITED STATES BY FEDERAL ENERGY ADMINISTRATION

FIGURE 3.4-7



SOURCE: DOUGLAS AND PARKER "PHOSPHATE INDUSTRY REBOUNDS", NATIONAL FERTILIZER DEVELOPMENT CENTER

U.S. AND WORLD CAPACITY FOR PRODUCING P_2O_5

FIGURE 3.4-8

3.5 RADIOLOGICAL

The baseline conditions of the radiological environment of the site have been summarized in Section 2.9. The proposed Swift Creek Chemical Complex may alter these baseline conditions. The purposes of this section will be: (1) to describe the redistribution of the radioactivity and radiation due to the activities of the proposed plant, (2) to propose all potential contamination and exposure pathways for this type of pollutant, (3) to predict or estimate from the best data available the effects on man or the environment, (4) to provide a comparative measure for each end-point against which the effect can be placed in its proper perspective, and (5) to substantiate the basis for mitigative measures (see Section 5.5) whenever such procedures are necessary.

3.5.1 RADIOACTIVITY BALANCE

The following discussion will attempt to follow the flow of radioactivity through the mining, beneficiation, and fertilizer production for the proposed plant. Data are based both upon measured activities at the north Florida site and comparison to the more intensively investigated west central Florida plants. Actual concentrations will not be known until the plant is operational, however, this discussion will attempt to use conservative data (i.e., those that may overestimate adverse effects).

In the mining process, the overlying topsoil, sands, strata, and leached zone (if present) must first be stripped away to gain access to the phosphate matrix. These overlying materials are collectively known as overburden and may be piled into the previous mine cut resulting in a series of spoil banks. Core analyses have shown the radium-226 profile in north Florida overburden to range from less than 1 pCi/g near the surface to over 10 pCi/g at the matrix interface. A dragline cannot precisely divide the strate and thus overburden may include some matrix.

Reclamation of these overburden spoil banks may include simple earth moving to yield a so-called land and lakes configuration. The general end result of this type of mining and reclamation technique would be to change this radium-226 profile into a more uniform one with depth, and having some average concentration of radioactivity higher than the original topsoil but much lower than the highest fraction in the profile.

In the west central Florida operations, topsoil (∿ 0.2 pCi/g), overburden (∿ 3 pCi/g), leached zone material (∿ 18 pCi/g), and inadvertant matrix (38 pCi/g) became reclaimed overburden with a rather homogenous radium-226 profile having between 4 and 8 pCi/g (Roessler, December 1977). The near surface concentration in such lands is, of course, quite variable, but the general average for large tracts is well documented.

For the north Florida site, the topsoil and inplace overburden appears to both be somewhat lower in radium than west central Florida. The near matrix and matrix levels of radium-226 are also about one-fifth that of west central Florida. Therefore, the resulting mixture in reclaimed overburden should be lower than in west central Florida. The expected level depends upon the depth of overburden and whether or not a higher activity zone exists just above the matrix. The only data available to confirm this hypothesis of lower activity reclamation lands are two cores taken on reclaimed land in an earlier study at Occidental (Sholtes & Koogler Environmental Consultants 1976). See Table 3.5-1. The first entry is the more important. The composite radium-226 concentrations in the first 20 feet are 6.6 and 2.8 pCi/g for the respective cores. It is not known whether the reclamation of this area included any other waste products, however, the gamma survey of the area suggested that pebble was visible in some locations. This reclamation area may represent a "worse-case" technique for the north Florida area, since the reclamation occurred before the associated radiation problem was identified.

The matrix must be removed and slurried to a washer/beneficiation plant. In general, the first step produces a course product known as pebble, an intermediate sized product known as flotation feed, and a fine clay product. The latter may be about 30 percent of the incoming weight and has no use. These clays are in a liquid slurry (about 3 percent solids) and the liquid must be recovered for reuse. Thus the clays are routed to a settling area. There the fine particles settle and the supernatant is deranted for recycle. The clays in west central Florida have a higher concentration of radium-226 than the input matrix (both on a dry weight basis) and the level depends upon the efficiency of the washer plant. The west central Florida clays average about 45 pCi/g for radium-226. By comparison to matrix values, the clays at the proposed site in north Florida should be near 10 pCi/g.

Abandoned clay areas are unsuitable for direct use. Reclamation may include capping with other material or a continuous reclamation program involving both sand and clay mixed. Continued radium-uranium equilibrium in older reclaimed clay settling areas may suggest that radium has not been leached during the extended contact with the aqueous environment.

The coarse fraction from the washer plant, pebble, also has a concentration of radium in excess of that in the matrix. In this coarse fraction the differences between north and west central Florida values become less, since the west central Florida pebble averages about 57 pCi/g and the north Florida level is near 26 pCi/g (Roessler, Dec. 1977). Thus the 1 to 5 difference between the two geographical areas in the matrix is reduced to 1 to 2 difference in a major product.

The second physical processing step is flotation and the two fractions produced are the concentrate and a sandy waste fraction usually termed tailings. The tailings represent about 40 percent by weight of the incoming matrix, but should contain little phosphate (about 10 percent) and a small fraction of the radioactivity. The west central Florida tailings average about 5 pCi/g. (Roessler, Dec. 1977). Samples from two tailings piles at the Occidental mine in 1976 both resulted in radium-226 concentrations of 3 pCi/g (Sholtes & Koogler Environmental Consultants 1976). Thus the 1 to 2 factor between regions was repeated for this waste fraction.

The concentrate from the flotation plant is of concern from the point of view of input to the chemical plant and as a source material in analysis of potential occupational hazards. The regional factor of 2 is duplicated in the concentrate also with west central Florida concentrate averaging nearly the same as the matrix (32 pCi/g), while the north Florida concentrate has a radium-226 level almost twice that of the parent matrix or about 18 pCi/g.

In summary, the three primary materials available for land reclamation at this north Florida site are mixed overburden with a radium-226 concentration up to about 5 pCi/g, a sandy tailings fraction with a concentration of about 3 pCi/g radium-226, and the clay fraction with a radium-226 level of approximately 10 pCi/g. These numbers are compatible with the limited data in Table 3.5-1 from cores on reclaimed land at the site. With planned reclamation, it should be possible to maintain the near surface radium-226 below 4 pCi/g. The consequences of this level will be discussed in another section.

3.5.1.1 Phosphoric Acid Plant and Fertilizer Production

Table 3.5-2 summarizes the input-output balance in radioactivity for the chemical processing phase. It is immediately obvious that the north Florida site has the same distribution of activity as west central Florida but that the levels are all less by about a factor of two. Since the west central Florida operations have been operating longer, and investigated more intensively, the following conclusions can be drawn by comparing this site to west central Florida.

1. Occupational hazards of handling input materials should be less.
2. Uranium recovery from the phosphoric acid is considered to be less feasible.
3. Radioactivity shipped in products should be less.
4. The chemical processes within the plant should present less occupational hazards.
5. Gypsum represents about one-half the source term for radioactivity than a similar quantity in west central Florida.

That is not to say, however, that the radioactivity at this north Florida site does not pose a potential hazard to man. The data suggest that techniques and procedures formulated to control radioactivity in west central Florida should be more effective in north Florida. Since west central Florida mining has a longer history and higher concentrations, adverse effects are more likely to have appeared and this data can be applied to long term predictions at the north Florida site.

3.5.2 EXPOSURE PATHWAY

Table 3.5-3 summarizes the various potential radiation pathways to man from the phosphate industry. In general, the radiation exposure source can range from a simple outcrop of the ore or high activity areas near the matrix, through the entire processing and product manufacture and into the distant future when stripped mine areas are reclaimed and returned to some other use.

The pathway to man may be as simple as direct gamma radiation from the redisturbed source to very complex pathways involving uptake through crops. The exposed population can be the workers within the mine or plant, the general public such as those who build on reclaimed land, or members of the public that are remote from the site such as those that utilize water from rivers or groundwater sources that are affected by the mining.

The inplace ore and overburden is mentioned as a source of radiation exposure in Table 3.5-3 because the contaminant, namely uranium and its daughter, radium-226, is present in almost any soil or strata and particularly in the area may be higher just before mineable matrix is reached. Thus, a potential pathway is the simple exposure of this material via the strip mining process.

The source of radiation exposure by the various physical and chemical processes leads to two general pathways; namely, occupational for those workers that must work with or be near the materials, and the general public may become involved by the transport of the radioactive materials from the processes, either by airborne emissions or through water contamination.

The source listed as product use is less important for this particular northern Florida site because the radioactivity in the product is less and because the north Florida site represents a fairly small fraction of the total phosphate production that would contribute to pathways of crop uptake.

The waste products, namely sand tailings, clays, gypsum and potentially contaminated waters should be considered as a major source of potential radiation transport to man. The first three products represent a considerable quantity of radioactivity that will be a potential hazard for centuries unless they are properly handled at the time of their production. Water losses during the operation can be monitored and long term effects should be considered.

By-product utilization should not be a significant problem. The sand fraction is suitable for a fill material and should not cause significant problems. Its use in building materials, however, has not been considered and the question is open. The use of gypsum as a soil conditioner is also open to question. Little data is available. The increased calcium in soil due to such practices may help the plant discriminate against radium naturally occurring in the soil. On the other hand the increased radium due to the radioactivity in the applied gypsum may be readily available to the crop. Crop-to-crop differences may also exist. Literature is very limited on this topic.

Land reclamation is a pathway of major concern at this time. The problem of returning land to residental development in north Florida is certainly not as great as in west central Florida where population growths are high and land is sought for this purpose. The reclaimed lands in north Florida will certainly be primarily used for either natural or agricultural purposes for many, many years to come. This is not to say, however, that the land should not be reclaimed in a manner that would allow unrestricted residential development.

3.5.3 IMPACT OF RECLAIMED LAND ON GAMMA RADIATION

The radiological survey of the Occidental Chemical Company mines and plants in early 1976 (Sholtes & Koogler Environmental Consultants, 1976) included gamma radiation measurements on areas which had been mined and reclaimed. It should be pointed out that this land had been mined and reclamation started for a number of years (as early as 1973), well before the knowledge of the potential for increasing radiation levels. Therefore, these readings may serve as an estimation of the "worse case" situations for this north Florida site. For example, both in the virgin land survey and here, evidence was found for the practice of using excess "pebble" for resource material for stabilization of roadway and parking lots.

Since this reclaimed area is near the existing chemical complex, measurements near liming ponds and discharge streams are included on the same figures. These data are summarized in Figures 3.5-1, 3.5-2, and 3.5-3 and Table 3.5-4.

The first series of measurements in a reclaimed area were made in the northeast quadrant of Section 11, T1S, R15E. See Figure 3.5-1. The measurements were near the water's edge. The gamma levels were highly variable and could be intuitively correlated with the amount of "pebble" visibly exposed. The mean of the six readings was 8.4 μR/hr.*

Measurements made in Section 12, T1S, R15E are summarized in Figure 3.5-2. The two readings for reclaimed land also averaged 8.5 μR/hr. The gamma level of 25.1 μR/hr is in the center of a parking lot used for various recreational events. The lot was constructed with phosphate pebble before its inherent radioactivity was recognized.

Table 3.5-4 summarizes the data taken primarily in Section 2, T1S, R15E. The reclaimed area is in the northwest quadrant. Two data points are just to the west, inside Section 3 and one is to the north in Section 35, T1N, R15E. The average level of these 20 readings is 7.8 μR/hr with a range from 4.7 to 15.6 μR/hr. The high reading was found on the hill just south of the pond. The higher readings could again be intuitively correlated with visible pebble in the surface soil.

---

* As corrected to plane source calibration discussed in Section 2.9.

The single point just south of the plant near the southern border of Section 35, T1N, R15E was taken near a plant discharge stream. The level was 13.4 μR/hr.

Four readings were taken at the south end of the liming ponds. (See Figure 3.5-3, southwest quadrant of Section 2, T1S, R15E). The average level near these ponds was 18 μR/hr with a range of 9.7 to 29.9 μR/hr. The liming process should easily precipitate radium-226.

3.5.4 SURFACE WATER SURVEILLANCE FOR POSSIBLE IMPACT

Table 3.5-5 summarizes the radioactivity measurements on 18 surface water and sediment stations. For each station a surface water was collected and a companion sediment sample was obtained at the same time. All samples in Table 3.5-5 were collected on either October 23 or 24, 1977. The first 10 stations are on Swift Creek, a tributary to the Suwannee River which has its headwaters in the Swift Creek Swamp. Both the Swift Creek Chemical Complex and the Suwannee River Chemical Complex will contribute to most stations on Swift Creek.

A brief discussion of the several parameters on Table 3.5-5 is appropriate. Gross alpha determinations in water are considered to be an acceptable screening procedure. The EPA has used gross alpha determinations for drinking water surveillance since gross alpha determinations are much less expensive and time consuming than the specific determination of radium-226. The current drinking water screening value for gross alpha in water is 15 pCi/l. Radium-226 is an alpha emitter and there are other alpha emitters in the radium decay chain as well as in the heavier uranium series radionuclides. Therefore, the gross alpha concentrations should always exceed the concentration of radium-226. Normal lower limits of detection for gross alpha in water are lower than indicated in this table. These gross alpha determinations had to be corrected for the amount of dissolved solids in the sample. These surface waters caused rather high correction factors, leading to high lower limits detection.

The radium-226 values are reported in picocuries per liter. Normal limits of detection for radium-226 in "clear" water should also be somewhat lower. The sediment samples were analyzed by high resolution gamma spectroscopy, a technique reported by Bolch (1976). All values are reported on a dry weight basis. The uranium values are given in ppm, however, they may be readily converted to pCi/g by dividing the concentration values by three. The column labeled Ra/U is an attempt to determine whether radium-226 is in equilibrium with its uranium-238 source. A value less than unity would indicate either radium has been leached from the sample or that uranium has been concentrated in the sample. The former explanation is thought to be the usual condition. If the uranium concentration value had a high error associated with it, the Ra/U ratio was not computed.

Since the high resolution gamma spectroscopy printout shows other gamma emitters present, it was simple to report these when they occurred more than randomly and at significant concentrations. Cesium-137 is a fallout radionuclide present in the deposition from Chinese weapons testing over the past two years. Since seven of the eighteen samples indicated a value with some confidence, the cesium-137 concentrations were reported. Also, potassium-40 is a naturally occurring radionuclide that is somewhat indicative of organic matter in the sample. Only four of the eighteen samples do not indicate a positive value of potassium-40.

The last column in the table is an attempt to roughly indicate the distribution of radium-226 between the water phase and the solid phase. A distribution coefficient, the ratio of concentration in the solid phase to the concentration in the liquid phase, is a correct parameter in some ion exchange or chromotography work. Whether or not it applies to surface water is in question, however, the overall indication is that it has some validity. Only half of the samples have both a positive result for radium in water, and radium in sediments.

A company sponsored radiological survey in January of 1976 (Sholtes & Koogler Environmental Consultants 1976) included two surface water samplings. The sample taken at Roaring Creek yielded a radium-226 concentration of < 0.8 pCi/l and the West Branch of Swift Creek waters had a concentration of < 0.6 pCi/l. Both results indicate a less sensitive analytical procedure but both limits are comparable to the current results listed in Table 3.5-5.

Only two of the stations on Swift Creek (SC-9 and SC-9.5) had positive results for gross alpha in water. The highest value was at station SC-9 which is in a channelized system and receives discharge from the Swift Creek Chemical Complex. The radium concentrations in water for the ten Swift Creek stations were all low, however, more positive results were obtained than with gross alpha since the radium-226 is a more sensitive test.

There is a general trend for increasing radium-226 in the sediments as one goes upstream on Swift Creek from the station (SC-1) at the confluence with the Suwannee River until station SC-9 is reached. Here the radium-226 in the sediments was 6.0 pCi/g. The same general trend, with some exceptions, appears in the uranium concentrations. Both analyses give the highest values to station SC-9. Most of the stations on Swift Creek indicate a value for radium-226 in the sediments that is lower than expected from equilibrium with the ppm uranium.

Only three of the ten stations on Swift Creek indicated a positive value for fallout cesium-137. These values are all near the limits of detection. The naturally occurring potassium-40 was present in eight out of ten of the Swift Creek samples. There is some indication that the five stations near the Suwannee River have lower organic matter (as indicated by potassium-40) than the five stations near the Chemical Complexes.

Because of the low values of radium in water for the Swift Creek samples, the value of the Kd calculations is questionable. The overall trend for all data, however, indicates that the radium-226 in the solid phase may be three orders of magnitude higher than the surface water above it.

The remaining eight samples were taken from five different water courses. The two stations (SR-7 and SR-8) on the Suwannee River seem to be entirely different although near each other. Station SR-7 is above the confluence with Swift Creek and SR-8 is below. Station SR-7 has very low values for almost all parameters whereas station SR-8 has significantly different values for radium-226 in water, radium-226 in sediment and potassium-40 in sediment.

The two stations at Roaring Creek and Hunter Creek have near identical values for almost all parameters.

With the exception of the uranium in sediments for station CB-3, all parameters for the three stations on Camp Branch appear to be not significantly different from within the three stations. Note especially that all three stations had positive indications of fallout cesium-137 in this rather remote area.

Only half of the surface water samples had levels of radium-226 above detection limits. The mean of the positive stations was only about 0.5 pCi/l and the range was from 1.2 to 0.3. The highest value found was in the Suwannee River. There appears to be no serious impact of present operations on the surface water from a radionuclide point of view. Radium-226 values in sediment are highly variable and range from 0.1 pCi/g to 6.0 pCi/g. The source of radium may be from both the natural stream bed and sedimentation of transported solids. There is little way to discern the source. One should note that the high value of 6 pCi/g in the sediments is near the Suwannee River Chemical Complex but a value of 2.7 pCi/g was found in sediments of Camp Branch near the Suwannee River. In conclusion, one can state that the radioactivity analyses appear to be consistent with physical knowledge of each station site.

The Osceola study (Miller 1977) also monitored the potential radiological contamination from streams in and adjacent to the Occidental mining areas. The limits of detection for their analyses was somewhat lower than those in the present study but the trend in the two data sets is consistent. The impact statement concludes that:

> "Radium-226 concentrations in Hunter Creek waters ranged from 0.02 to 0.23 pCi/l with a median of 0.11 pCi/L, or about the same as that of Rocky Creek (0.03 to 0.24 pCi/l, median of 0.08 pCi/l and only slightly higher than those of the National Forest streams. Correlation with discharge was

> not shown to be significant. As the range and median concentration of radium-226 in Hunter Creek was about that of the natural waters, it is concluded that the mining and beneficiation operations did not add significantly to the concentrations of this radionuclide in Hunter Creek.
>
> Radium-226 concentrations in Swift Creek ranged from 0.05 to 0.20 pCi/l with a median of 0.08 pCi/L during the period of study, which is comparable to concentrations in the 'natural' streams. Therefore, radium-226 concentrations in Swift Creek waters have not been enriched appreciably by discharge from any of the phosphate industry operations. No correlation was found between the radium-226 concentrations and discharge." (Miller 1977)

Even though the Osceola report concluded that the average radium-226 concentrations in the Occidental effluents would probably not exceed those in natural streamflow, it did suggest concern over accidental discharges. Certainly, water retained in many of the impoundments contain high radium-226 levels. The failure of a dam, dike or other barrier could result in a receiving stream having a high concentration of radium-226 for periods of time following the release. The Peace River did receive over 16.5 x 10^{12} pCi of radium-226 due to a phosphatic clayey waste settling pond failure in west central Florida (EPA 1974). The failure had an effect lasting much longer than the transient time of the slug of waste in that the sediment deposited throughout the streambed continuously leached out radium to the water for a period exceeding a year. The river water contained over twice the then current USPHS Drinking Water Standard for radioactivity for a year and one-half after the failure. However, surface water resources such as the Peace River is normally not used directly. Most types of water treatment would be expected to remove between 75 to 95 percent of the radium. Thus, the resource water could normally exceed four times the expected finished water.

3.5.4.1 Source Waters

Table 3.5-6 summarizes the radioactivity monitored in the various source ponds at SRCC. The eighth entry is for the return water ditch that should indicate seepage from settling areas at SCCC.

Many of these waters (i.e., gypsum stack and cooling ponds) had extreme high solids contents (over 20,000 mg/1). The analysis of gross alpha levels in such waters is precluded and the fractionation of the radium into dissolved and suspended portions becomes less definite.

In each case the first sampling was submitted for both gross alpha and radium-226 analysis and the second sampling was submitted for gross alpha with instructions to decrease the sample aliquot whenever the first test had too high solids content for accurate analyses. The third set followed a similar plan and yet only one additional gross alpha determination was made available by the procedure.

The gypsum stack and two cooling ponds have comparable radium-226 levels. Sampling of the cooling ponds in early 1976 also yielded similar levels with an indication that the new pond (No. 2) was still building up to an equilibrium level. The levels seen are not unexpected as they are less than one-half the concentration in similar holding areas in west central Florida.

Table 3.5-7 summarizes radium-226 concentrations in similar source waters of west central Florida. The gypsum stack waters in the various categories at both Florida locations correlate well with the general levels of matrix activity within the regions. The radium-226 value given for the outfall of a third stage liming pond in west central Florida is well below the target discharge level of 9 pCi/l radium-226.

For the north Florida site the situation is less critical since the direct dilution of primary source water necessary to achieve a discharge of 9 pCi/l radium-226 is only about 3:1 or a treatment scheme (i.e., double liming) would need to be 81 percent efficient to yield an effluent of 5 pCi/l. Under laboratory conditions double liming is 99.7 percent efficient in reducing soluble radium-226 and field studies indicated a range from 94 to 97 percent removal (Guimond 1975).

The chemical plant retention pond at the Suwannee River Complex had a solids content too high to yield a gross alpha measurement, however, the radium-226 was 4.9 pCi/l.

The radium activity in the two liming ponds was found to be nearly two orders of magnitude lower than the cooling ponds and gypsum stack. The levels were comparable to environmental levels. The concentration in the second liming pond was not found to be different from the Altman's Bay discharge. The Osceola study also took samples from the Altman's Bay discharge in October of 1976 and those results agree with the present study.

The levels of radium-226 in the return water ditch are low. The Osceola study sampled two spillways: #22 northeast of the existing complex and #27 due north of the chemical plant. Each of these yielded radium concentrations near environmental levels.

The dilution necessary to lower the radium-226 concentrations in these holding areas, in either the case of high rainfall causing some overflow or the case of seepage into groundwater resources, would appear to be available. Dilution factors of as high as 10:1 may be expected in either event. With a dilution factor of 10:1, any source water shown on Table 3.5-6 would be reduced to levels below the drinking water standards of 15 pCi/l gross alpha and 5 pCi/l total radium.

3.5.4.2 Groundwater Surveillance

Previous sections detail the rationale for selecting groundwater sampling stations, describe the location and characteristic of each well, and discuss the results of the water quality results other than radioactivity. This section will specifically address the radiological aspects of the surveillance program. Briefly, the well sets are designed to attempt to monitor possible seepage from several source waters into the shallow water table, surficial aquifer, and the deeper artesian aquifer. The six well sets at SRCC may be influenced by the several ponds in the area of the complex. In addition, existing industrial wells were sampled at SRCC.

At the SCCC two well sets were designed to monitor the proposed gypsum stack and two well sets for the proposed cooling pond. Two existing industrial wells at SCCC were also monitored.

Table 3.5-8 summarizes the data from six sets of wells at SRCC designed to monitor seepage from several of the surface water holding areas. Each well set consists of from three to four wells drawing water from selected depths: Well A being the most shallow and Well C or D being the deeper wells. The monitoring purpose is given in the left hand column, well results in the second and third column (i.e., SR-2-A for Well A in set number 2 at Suwannee River). Note that each well was sampled three times with the first series analyzed for both gross alpha activity and radium-226.

The gross alpha activity for the first sampling averaged at the six well sets at the SRCC 11 pCi/l with a range from 2.3 to 29 pCi/l. This appears to not be significantly different than the average and range observed in Alachua County (Palmer 1977).

The weighted average of the five categories of wells in the Osecola study was 10 pCi/l gross alpha activity. One must conclude that the first series of surveillance samples did not indicate a higher than expected gross alpha activity in the monitor wells.

The radium-226 analyses from the first series had an average of 1.7 pCi/ with a range of 0.2 to 7.5 pCi/l. This data is also comparable to that obtained by Palmer for Alachua County where no phosphate mining occurs (Palmer 1977). The Osecola study yielded a range of radium-226 concentration in various well types from <0.01 to 5.2 pCi/l for 16 samples.

When the gross alpha determination from both Table 3.5-7 and 3.5-8 are plotted against the radium-226 in the same sample, the correlation is fair and the slope (average gross alpha to average radium-226) lies between 6 and 7. The gross alpha to radium-226 ratio observed by Palmer is smaller (3-4) and by the Osceola study is larger (approximately 10). The difference may be due to the sample preparation techniques for the radium-226. One can conclude that for a given sampling and analysis regime, the gross alpha activity is a reasonable screening tool for monitoring. For a stable water quality range it may be an even better predictor of potential radium-226 levels. The EPA guideline for gross alpha activity in drinking water is 15 pCi/l; suggested to yield a radium content no greater than 5 pCi/l (or a ratio of 3:1).

Attempts to correlate either gross alpha activity or radium-226 with other water quality parameters was not succesful. Many high radium-226 levels were associated with high dissolved solids, but there were too many exceptions to draw a correlation.

The second series of sampling at SRCC nominally occurred one month after the first round. These data are shown in Table 3.5-8. The data exhibit an interesting phenomena; in 88 percent of the samples the gross alpha activity was lower in the second series. The average level of activity went down by a factor of slightly greater than two, yielding an average gross alpha activity of 4.8 pCi/l. This reduction could be caused by the "development" of the well since the initial sampling occurred a short time after the wells were drilled. If the gross alpha to radium-226 ratio continues to hold, the later set of screening samples would predict an average radium-226 concentration of about 0.8 pCi/l. Several second round samples were analyzed for radium-226 and data indicate the radium-226 levels were generally lower by an order of magnitude.

A third series of samples were taken in April 1977. The gross alpha data is shown in the last column of Table 3.5-8. The third series averaged 6 pCi/l gross alpha with a range from 2.0 to 12 pCi/l. Thus the levels were generally lower upon the third sampling. This trend would logically be attributed to well development.

The main purpose of the SRCC wells were to monitor the seepage from certain bodies of water containing higher radium-226 levels. The data can neither dramatically support nor emphatically deny this seepage. Other water quality parameters, especially those items that do not exist in nature, nor have such an ambiguous source, may be better predictors of water movement. Whether the highly insoluble radium will follow such movements is unknown.

The monitor wells at the proposed SCCC resulted in the data in Table 3.5-9. The same procedures used in the design, sampling and analysis for the SRCC program was used for these four well sets.

The immediate conclusion that can be drawn from this data is that the Swift Creek program yielded higher levels. The average gross alpha level on the initial sampling was approximately 16 pCi/l and the average radium-226 level was 2.2 pCi/l.

The ratio of the two parameters remained essentially unchanged. Also the pattern of the lower gross alpha activity in the second sampling was repeated with a reduction by better than a factor of 2 in the average. The data sets from the two areas may not be statistically different, however, this was not tested. Correlation with other water quality parameters was not observed.

The data from Tables 3.5-8 and 3.5-9 have been graphically presented in Figures 3.2-18 and 3.2-19. If the SCCC data graphs are considered without reference to other data, there would be a suggestion of contamination of zone "A" at sets 4 and 6, of zones "C" and "D" at set 6. However, the plots of the range of background values at SCCC on the right of each figure, clearly indicates that all data from any set and zone at SRCC is within the range of values observed at the undisturbed SCCC site.

There was an additional set of data available at the Swift Creek site: gamma logs of three wells. Inspection of the gamma logs seemed to indicate the following hypotheses:

1. The gamma log activity is directly related to the radium concentration in the soil at a given depth.
2. The gamma log of well SC-3-E should represent the gamma activity of the entire well set SC-3.
3. Each well in a set draws water from the screen depths as well as water from several feet above and below the screen.
4. The observed radioactivity levels in groundwaters at SCCC, when related to depth, suggest a correlation with gamma

> log activity. Thus, a probable influence of the local media near the well upon radioactivity levels in the water makes tracing of potential contamination at other locations less feasible.

Some well water data was also taken in a radiological survey of the Occidental Chemical Company site in 1976 (Sholtes & Koogler Environmental Consultants 1976). Table 3.5-10 shows this data which includes nine wells. The average radium-226 concentration in the six positive results in 2.1 pCi/l. One third of the results were less than the detection limit of 0.8 pCi/l. These data were performed in a different laboratory and by a method different from the current study.

Table 3.2-10 contains the groundwater quality data, including gross alpha activity, for existing shallow potable wells at Occidental. The maximum well depths range from 75' to 270' and the observed gross alpha concentrations ranged from < 1.2 to 18 pCi/l. Eight deep (700' to 1265') production wells at Occidental yielded a range of gross alpha activities of < 1.4 to 7.4 pCi/l (Table 3.2-11).

Table 3.5-11 contains additional gross alpha and radium-226 levels for two of the wells at SRCC and for two wells at SCCC. All radium-226 data appear to be consistent with the gross alpha determinations and other wells of north Florida. The highest radium-226 concentration was observed in the deepest well (M-1).

3.5.4.3 Occupational Exposures

The proposed chemical plant will alter the distribution of natural radionuclides present in the phosphate matrix. The concern of this section will be the potential for radiation exposure to the phosphate workers in the proposed plant. This concern was expressed in early 1976 by Windham (1976). An indepth study was conducted by Prince (1977) during the period March 1976 through May 1976. The bulk of this extensive study by Prince was conducted in west central Florida, however, sufficient data was collected in north Florida (specifically Occidental Chemical Company) to allow the prediction of potential hazards and precautions to be considered in the proposed chemical plant. A complete description of the proposed plant is given in other sections of this report. Also a mass balance of radioactivity has been previously considered showing the distribution and fractionization of the matrix radioactivity into waste fractions and product fractions and intermediate materials.

For the purpose of identifying the potential for occupational exposure the following categories will be used:

1. mining and wet rock operations consisting of:
    (a) the dragline site,
    (b) washer plant,
    (c) flotation plant,
    (d) wet rock storage and loading tunnels;

2. dry rock handling operations consisting of:
    - (a) rock drying and grinding,
    - (b) dry rock loading and unloading;
3. phosphoric acid manufacture consisting of:
    - (a) acidulation,
    - (b) filtration,
    - (c) filtration tanks,
    - (d) other plant areas,
    - (e) gypsum pond; and
4. phosphate fertilizer areas consisting of:
    - (a) production,
    - (b) storage,
    - (c) loading and shipping.

Prince has tabulated his survey results for all measurements and all plants. North Florida results were not broken out in his data, however, raw data values for the Occidental Chemical plant were available and these tabulations will be used in parallel tables to indicate the differences between the north Florida site and west central Florida.

A brief description of the potential for worker exposure will be described for each operation or category.

Dragline Site:

The three areas at the dragline include inside the dragline cab, inside the gun car and within the mine cut. However, the latter area has a very short residence time for any individual.

Flotation Plant:

The flotation plant is indoors and exposures may occur generally throughout the plant, inside control rooms and near material movement mechanisms.

Storage Bin Areas:

Here the exposure may occur on catwalks, over bins, at the bottom of bins, and near other piles.

Loading Tunnels:

Loading tunnels represent a special area that will be given particular consideration in the discussion. Exposure may occur inside or outside of the tunnel either before or during operation.

Dryer Building:

Within the dryer building exposure may occur inside control rooms or outside on catwalks or at ground level near bottom of cyclone.

Grinding Operations:

Exposure to individuals may occur in general area around ball mills and also control rooms when available.

Dry Rock Loading and Unloading:

Exposure here may come from the dry rock and storage bin, catwalks near the bins, and especially during the train car loading.

Phosphoric Acid Production:

The areas of concern in the phosphoric acid plant include around reactors, filters, hoppers, evaporators, and general areas throughout the plant. Control rooms and lab areas were also considered.

Polyphos Plant:

The general working area throughout the plant including weighing mill areas, granulators and other operations were considered.

Granulation Plant:

The general area throughout the plant was a potential concern, as well as inside the control room.

Product Storage and Shipping:

The general areas inside the warehouses and near loading areas that can be extremely dusty were of concern.

Miscellaneous:

The laboratory building was considered as well as administrative offices for the purpose of demonstrating differences in the natural background.

External Gamma

Although it was early realized that gamma radiation exposures would probably not present a hazard problem to the industry, the ease and accuracy of gamma radiation measurements made it a prime candidate for screening many areas for other potential hazards that could later receive more extensive sampling by other methods, in particular, radon daughter levels (working levels). Gamma scintillation survey meters are highly sensitive and extremely rugged. They are usually not variable under the most of environmental conditions.

Table 3.5-12 summarizes the gamma radiation measurements made in various areas of operation for both the Occidental Chemical Company complex and a data summary for all plants Prince surveyed in Florida (1977). In each area data is listed for the average gamma readings (μR/hr) and the observed range. Also the number of plants is given for the Florida summary and the number of measurements is noted for the Occidental Complex. In the summary of Florida mines or plants, the number will actually represent a larger number of measurements. For example, the two measurements at dragline areas made at Occidental would be average to obtain one measurement for the summary of all Florida mines or plants.

There are some apparent inconsistencies in the table due to the fact that the Florida summary may or may not include the Occidental data. In addition, the summary in the Occidental Chemical Company columns was performed by a different person and the total data available may not be exactly the same or the method of averaging may not have been duplicated. For example, the data under mining and wet rock subsection "Wet Rock Storage Bins" appears to be inconsistent. The plant average for Occidental is 14 μR/hr for this area. The range for all mines and plants in Florida is given by Prince to be from 17 to 58 which would indicate that the Occidental data was either averaged differently by Prince or that other data were included in this sub-area. The difference between 14 and 17 μR/hr may not be significant and will not change basic conclusions of the overall table.

The immediate conclusion one can draw from this table is that, in general, the Occidental Chemical Company plant data often represents the lower portion of the range of data in the total summary for all Florida plants. In almost all cases the average for the Occidental complex is lower than the average of all Florida plants. In addition, the Occidental Chemical Complex averages are at or near the lower value in the range column for the summary of all Florida plants.

Within the mining and wet rock areas, the highest readings were taken in the wet storage piles. Residence times for individuals near these piles is low. The north Florida value is about one-half that of the total summary value. Even a 40 hour per week exposure at this location would translate to an annual exposure of about

50 mR. The four areas in the dry rock subsection show smaller gamma measurements at the Occidental Complex than in the other plants throughout the State.

The next two sections of the table, wet processing phosphoric acid and fertilizer production, are indicative of the chemical procedures. It might be expected that the north Florida site would produce radioactivity concentrations in process materials that were comparable to west central Florida. To some extent this occurs, but measurements show that the north Florida plant is still at or near the lower limits in the ranges of all Florida plants. Under the subsection "Phosphoric Acid" the only interesting piece of data is for inside the reactor. Here a scale is apparently built up that is particularly able to concentrate the radioactivity. The measurement of 125 µR/hr is rather high. Extreme caution should be taken for cases where these reactors are cleaned.

The "Fertilizer Production" section shows nearly equal averages for the Occidental Plant as for the total summary. The very high readings around filtrate tanks obtained at other plants were not evident at the Occidental Chemical Complex.

For the purposes of putting these gamma radiation measurements into a perspective with respect to acceptable radiation standards let us consider the exposure rate listed for the wet rock storage piles. The average value listed, 29 μR/hr, includes a natural radiation background of approximately 5 μR/hr, yielding a net enhancement of 24 μR/hr. Workers in the phosphate industry should not be considered radiation workers and industry should not consider restricted areas as defined in other radiation industries. Therefore, exposures to phosphate workers should be considered as members of general public in areas defined as noncontrolled or unrestricted. With these guidelines one can compare the data to a general public radiation protection standard of 170 mrem/hr for a continuous exposure for a 40 hour work week. The 24 μR/hr value would translate to about 80 mrem/yr. Thus, continuous 40 hour occupancy on the wet rock storage pile would indicate an exposure some three times less than the generally accepted protection guide for the general public. Any other measures such as shielding by the earth moving equipment itself or occupancies less than 40 hours per week will greatly reduce the hazard potential.

The other generally accepted philosophy in radiation protection is to keep radiation exposures "as low as practical" (ALAP) or "as low as reasonably achievable" (ALARA). As the industry becomes aware of the potential areas where radiation levels are somewhat elevated they should institute measures to meet this generally accepted philosophy. The highest reading for gamma levels at the Occidental Chemical Complex was inside the reactor in the phosphoric acid plant. Even though the occupancy factor for cleaning these reactors would be very small, the industry should consider any practical method of cleaning that reduces close contract with the inside of the reactor. In general all the gamma radiation measurements at Occidental Chemical appear to be elevated no more than one may find in homes or offices made of brick, concrete block and stone outside of the phosphate areas.

Radon Progeny

Although gamma radiation measurements indicate that the north Florida chemical plants and mines may not have any appreciable problem with airborne radon progeny inhalation, some measurements were continued by Prince in order to validate this assumption. (Prince 1977). The usual method for measuring radon progeny is by high volume air samplers and counting the alpha activity under various time and filter placement restrictions. The readings are converted to the unit of Working Levels as explained earlier in this report.

Table 3.5-13 summarizes the results of Prince (1977) for all Florida mines and plants compared to the limited data taken at the Occidental Chemical Complex. The entire spectrum of measurements for other Florida mines and plants has been reported in order to provide some estimation of what the hazard may be at the north

Florida site. In general, most measurements in north Florida were in the lower range of the summary of plant measurements. The three subcategories under mining and wet rock show that the north Florida sites were not the lowest plants measured. However, the three categories are at locations where the variability in Working Levels is extremely influenced by certain environmental conditions and operational parameters. The two Working Level measurements taken in the wet process phosphoric acid areas were, respectively, the lower two measurements made in the numerous plants visited.

In order to place these readings into proper perspective one must compare them to generally accepted radiation standards. The history of Working Level measurements in uranium mines and the relationships to potential lung cancer development is well documented. An early standard for uranium miners was 12 Working Level Months per year. This translates to 170 hours per month exposure at 1 Working Level. The standard for uranium miners is four working level months annual exposure. The value of four working level months per year converts to a 170 hour working environment at 0.33 Working Levels. The highest value in Table 3.5-13 for the Occidental Chemical plant is 0.055 WL (55 mWL) inside a storage tunnel. This value is some six times lower than the uranium mine standard. The occupancy factor in storage tunnels would be considerably less than 170 hours per week.

Storage Tunnels

The storage tunnels, however, do represent one area that should be of concern to the industry. This is especially evident when the high of 0.960 mWL (960 WL) value for the highest Florida plant is considered. This is about three times the uranium mine standard. A important variable in storage tunnels is whether the conveyor is in operation and whether there are any ventilation fans working.

For the purposes of Prince's study, a tunnel was considered to be operating when wet rock was being loaded through a tunnel gate onto the conveyor belt for transfer to drying or loading facilities. Comparisons of working level concentrations made under operating and non-operating conditions are tabulated in Table 3.5-14. The first obvious point that should be made, is that the levels vary by almost three orders of magnitude. Many environmental conditions may contribute to these high variations. Somewhat surprising is that the two additional measurements at the Occidental site had consistently high values of Working Levels under operating conditions. Two west central Florida plants produced maximum readings that exceeded the one value taken at each of the three Occidental tunnels.

It can be seen that the concentration ratios of operating versus non-operating status range from 0.4, a tunnel where mechanical ventilation worked during operating and non-operating conditions, to 66, the value obtained at the Occidental Chemical Company.

plant tunnel K-2E. This is of course based upon only one operating measurement. Prince has suggested that these ratios will be unique for any given tunnel and that along with ventilation conditions the operating status will have the greatest influence on radon progeny measurements in these tunnels. He suggests that ventilation is the best means to keep unwanted levels, for any hazardous airborne substance from building up within a confined location.

One set of data (Table 3.5-15) provides a limited view of the effect of mechanical ventilation. Here the ratios of levels for ventilation-on versus ventilation-off was 65. This ratio may again be unique to one complex, but it does give an indication of the degree of airborne radon progeny buildup when ventilation is turned off. The data given in Table 3.5-15 for company H in west central Florida also supports this conclusion, for there no increase was observed in radon progeny concentration when the tunnel went from a non-operating to an operating status.

It does appear than the tunnels provide a sufficient hazard potential that they should be considered by the company for mechanical ventilation and for limited access by personnel.

3.5.5 SUMMARY

The radiological impacts of the proposed SCCC are as follows:

Gamma Radiation

Occupational Within Plant - Gamma levels will not require any controls. Normal occupancy times at elevated locations lower accumulated doses to within normal background variations.

Radon Progeny in Plant - The only high Working Levels found were in loading tunnel now lowered to insignificant levels with forced ventilation.

Surface Water - This and previous studies have not observed surface water radium-226 concentrations in excess of natural streams. Current treatment technology has proven to be adequate to limit discharges to less than 5 percent of allowable concentrations of 9 pCi/l radium-226.

Groundwater Radioactivity - This and previous studies have not observed groundwater radium-226 concentrations in excess of background in non-mining areas. Radium-226 in groundwaters appears to be associated with local subsurface environment and other water quality factors.

Product and By-Product Radioactivity - The chemical processing will factionate the wet phosphate concentrate feed into SPA with expected radium-226 and uranium-238 concentrations at 0.2 and 21 pCi/g, respectively, and gypsum with 14 pCi/g Ra-226 and little uranium (<0.5 pCi/g). The uranium in the acid converts to about 60 ppm and recovery is not economically sound. The gypsum matrix of high sulfates keep radium in an insoluble state. The gypsum stack should be covered with low permeability soil at the time of retirement.

The radiological impacts of the associated mining and beneficiation are as follows:

Subsurface Radioactivity - Pre-mining radium-226 profiles (1 pCi/g at surface to 10 pCi/g near matrix) will be altered to a mixed overburden of between 3 and 7 pCi/g.

Matrix Radioactivity - Radium-226 (8 pCi/g) in the matrix will be fractionated into clays (10 pCi/g), pebble (26 pCi/g), sand tailings (3 pCi/g), and concentrate (18 pCi/g).

- Uranium in the matrix will follow the radium-226 in physical separations.

Gamma Radiation Reclaimed Lands - The mean outdoor gamma radiation is expected to be elevated from 5 μR/hr to somewhat less than 8 μR/hr.

Table 3.5-1 Radioactivity Profiles on Reclaimed Land at Occidental Chemical Company

Description	Ra-226 pCi/g	Uranium pCi/g
Section 2, T1S, R15E		
0 - 20'	6.6	5
20 - 30'	4.8	4.3
31 - 41'	19	12
Section 12, T1S, R15E		
0 - 20'	2.8	ND
20 - 28'	5.5	4
28 - 41'	9.6	6.3

Source: Sholtes & Koogler Environmental Consultants 1976

Table 3.5-2 Radioactivity Balances for Phosphoric Acid Plants and Fertilizer Production: Occidental Chemical Company Compared to West Central Florida

Sample Type	226 Ra, pCi/g		238 U, pCi/g	
	Occidental	W. Central Fla.	Occidental	W. Central Fla.
Input Materials				
Pebble	26	57	23	46
Concentrate	18	37	13	32
Products				
30% Phosphoric Acid	-	0.4	-	30
40% Phosphoric Acid	0.2	-	21	-
Ammoniated Phosphates	0.5	4	25	70
Triple Super Phosphates	12	20	26	56
Inplant Materials				
Acid Reactor Scale	22	-	11	-
Filtrate Tank Scale	-	380	11	-
30% Tank Sediment	-	84	-	<1
Waste Material				
Gypsum	14	32	<0.5	<0.5

Source: After Roessler, December 1977

Table 3.5-3 Potential Radiation Exposure to Man

I. Source of Radiation Exposure	II. Pathway to Man	III. Exposed Population
A. In Situ	A. Direct Irradiation (Gamma)	A. Occupational
1. Overburden 2. Ore	B. Atmospheric Releases Inhalation	B. General Public - Immediate Vicinity
B. In Process	1. Particulate	C. General Public - Remote Sites
1. Strip Mining 2. Slurrying 3. Beneficiation 4. Drying 5. Chemical Plant (Phosphoric Acid and Fertilizer Manufacture)	a. Mining b. Post mining c. Stored raw materials d. Drying (if present) e. Loading and transferring	
C. Product Use (Fertilization of Crop Land)	2. Radon and Daughters	
D. Waste Products	a. Reclaimed land ambient b. Structures on reclaimed land c. In Plant	
1. Sand Tailings 2. Clay Settling Ponds 3. Gypsum Stacks 4. Water Losses 5. Water Discharges	C. Surface and Ground Water Contamination 1. Drinking Water 2. Crop Irrigation 3. Crop Uptake from Soil Water	
E. By-Product Utilization	D. Food Crops	
1. Sand-Fill, aggregate, paving, construction 2. Gypsum (soil conditioner, Wallboard [proposed]) 3. Pebble (road construction)	1. Uptake (reclaimed Land) 2. Irrigation 3. Fertilizers and Soil Conditioners	

Table 3.5-3 Potential Radiation Exposure to Man
continued

I. Source of Radiation Exposure	II. Pathway to Man	III. Exposed Population
F. Land Reclamation		
1. Return to virgin areas		
2. Return to agricultural uses		
3. Return to residential development		

Table 3.5-4 Data for Figure 3.5-3

Point No.	Gamma Level (μR/hr)	Comments
1	6.1	
2	7.5	Centerline of Road
3	5.5	
4	5.3	
5	5.8	
6	4.7	
7	4.7	
8	6.1	
9	10.4	
10	8.6	Ground level at #10 up 20.1 μR/hr
11	15.6	
12	13.1	
13	7.2	
14	5.8	Water's Edge (1' deep)
15	8.1	
16	13.1	
17	5.3	Section 3
18	13.7	
19	4.4	Section 3
20	5.8	Section 35
21	13.4	Section 35
22	9.7	
23	29.9	
24	18.7	
25	13.7	

Table 3.5-5 Radioactivity in the Surface Waters of the Property

STATION No.	DESCRIPTION	DATE SAMPLED	WATER Gross Alpha	WATER Ra-226	SEDIMENT Ra-226	SEDIMENT U	SEDIMENT Ra/U	SEDIMENT Cs-137	SEDIMENT K-40	SEDIMENT Kd*
			pCi/l	pCi/l	pCi/g	ppm	pCi/pCi	pCi/g	pCi/g	pCi/g / pCi/ml
SC-1	Swift Creek	10/23/77	< 2.1	<0.2	0.53	1.1	*	< 0.04	0.82	> 3,000
SC-2	Swift Creek	10/23/77	< 3.0	0.3	0.73	4.6	0.5	< 0.04	< 0.76	2,000
SC-3	Swift Creek	10/23/77	< 0.7	<0.4	0.47	1.8	0.8	0.08	0.77	> 1,000
SC-4	Swift Creek	10/23/77	< 2.5	<0.4	0.80	5.9	0.4	< 0.03	0.68	> 2,000
SC-5	Swift Creek	10/23/77	< 0.8	<0.3	0.47	4.0	0.4	0.06	0.41	> 2,000
SC-6	Swift Creek	10/23/77	< 1.6	<0.3	2.9	15.0	0.6	< 0.07	1.6	>10,000
SC-7	Swift Creek	10/23/77	< 2.2	0.4	1.3	4.0	1.0	< 0.05	1.2	3,000
SC-8	Swift Creek	10/23/77	< 1.3	0.5	3.3	15.0	0.7	< 0.07	< 0.73	7,000
SC-9	Swift Creek	10/23/77	3.1	0.3	6.0	24.0	0.8	0.09	1.5	20,000
SC-9.6	Swift Creek	10/23/77	1.9	0.3	0.69	3.9	0.5	< 0.06	1.9	2,000
SR-7	Suwannee River	10/23/77	< 2.3	0.3	0.08	0.5	*	< 0.04	< 0.79	300
SR-3	Suwannee River	10/24/77	< 1.9	1.2	1.2	1.1	*	0.08	2.0	1,000
RO-2	Roaring Creek	10/23/77	2.7	< 0.2	1.6	6.9	0.7	< 0.06	2.0	> 8,000
HC-1	Hunt. Creek	10/23/77	2.9	0.3	1.9	6.2	0.9	< 0.05	0.87	6,000
RC-2	Rocky Creek	10/23/77	< 1.9	< 0.3	0.12	1.8	*	< 0.03	< 0.42	> 400
CB-1	Camp Branch	10/24/77	< 0.9	0.5	2.7	7.5	1.1	0.31	1.4	5,000
CB-2	Camp Branch	10/23/77	< 0.5	< 0.3	1.2	6.2	0.6	0.09	1.5	> 1,000
CB-3	Camp Branch	10/23/77	< 1.5	< 0.3	0.62	0.3	*	0.18	1.9	> 2,000

* For radium-226

Table 3.5-6 Radioactivity in Selected Source Waters at the Suwannee River Chemical Complex

	Radioactivity, pCi/l						
Description	Date Sampled	Gross Alpha	Radium-226	Date Sampled	Gross Alpha	Date Sampled	Gross Alpha
Gypsum Stack, Dorr-Oliver	1/17/78	*	26.2	2/24/78	*	4/18/78	*
Cooling Pond #1	1/17/78	*	24.8	2/28/78	*	4/18/78	*
Cooling Pond #2	1/16/78	*	23.8	2/24/78	*	4/18/78	*
Chem. Plant Ret. Pond	2/28/78	*	4.9			4/17/78	10.7
Liming Pond #1	2/28/78	*	0.3			4/18/78	*
Liming Pond #2	2/28/78	*	< 0.2			4/18/78	43.9
Altman's Bay Discharge	2/28/78	1.8	< 0.2			4/18/78	4.3
Return Water Ditch**	1/18/78	7.2	0.3	2/23/78	3.8	4/19/78	3.4
Previous Data:(1)							
Cooling Pond #1	1/27/76	-	30				
Cooling Pond #2	1/27/76	-	12				
Previous Data:(2)							
Altman's Bay Discharge	10/18/76		< 0.1				
Spillway #22	10/18/76		0.6				
Spillway #27	10/18/76		0.5				

*Solid Content too high for accurate measurement

** Swift Creek

(1) Sholtes & Koogler, 1976
(2) Miller, 1977

Table 3.5-7 Typical Source Water Radium-226 Concentrations in West Central Florida

Location	Dissolved Ra-226, pCi/l	Reference
Gypsum Stack Water	88	Windham 1974
Gypsum Stack Slurry	35	Windham 1974
Gypsum Water without Recycle	50	EPA 1973
Gypsum Water with Recycle	90-100	EPA 1973
Process Pond Water	75 (3 samples)	Windham 1974
Outfall Third Stage Liming Pond	1.0	Windham 1974
Slime Pond Influents and Effluents	< 2	Guimond 1975

Table 3.5-8 Radioactivity in Monitor Well Sets at the Suwannee River Complex

Monitoring Purpose	Well Set	Well No	Depth Range, ft.	Radioactivity, pCi/l Date Sampled	Gross Alpha	Radium-226	Date Sampled	Gross Alpha	Date Sampled	Gross Alpha
Seepage from Existing "CTC" Gypsum Stack:	SR-2	A	2-13	1/24/78	10.1	0.9	2/23/78	2.9	4/17/78	4.7
		B	38-49	1/24/78	5.8	2.5				
		B	32-49	1/24/78	12.7	3.7	2/23/78	6.3	4/17/78	2.0
		C	124-144	2/7/78	5.9	0.9	2/23/78	<2.1	4/17/78	< 2.2
Same as SR-2 except for 100' W for gradient:	SR-1	A	1-11	1/24/78	6.6	0.3	2/23/78	10.4	4/18/78	*
		B	21-38	1/27/78	8.8	0.8				
		B	21-38	1/24/78	28.6	7.5	2/23/78	5.4 (a)	4/18/78	< 3.0
		C	110-129	2/7/78	7.5	1.5	2/24/78	<2.4	4/18/78	< 2.4
Seepage from Existing "Dorr-Oliver" Gypsum Stack:	SR-6	A	2-12	1/24/78	29.4	3.8	2/24/78	* (b)	4/17/78	*
		B	21-35	2/7/78	3.9	0.5	2/24/78	* (c)	4/17/78	*
		C	73-93	1/24/78	19.9	1.9	2/24/78	<1.7	4/17/78	< 2.8
		D	105-125	2/7/78	21.9	2.0	2/24/78	<3.1	4/17/78	< 2.6
Synergistic Effect of "Dorr-Oliver" Gyp. Stack & Existing Cooling Pond No. 1:	SR-5	A	2-14	1/24/78	19.8	1.8			4/14/78	7.1
		B	20-40	2/7/78	6.8	1.0	2/24/78	10.8	4/14/78	12.0
		C	70-80	1/24/78	2.7	0.9	2/24/78	6.7	4/14/78	10.0
		D	100-119	2/7/78	3.6	0.7	2/24/78	<2.6	4/14/78	< 2.3
Seepage from Cooling Pond No. 1	SR-4	A	3-18	1/24/78	25.6	3.4	2/23/78	9.6	4/13/78	8.4
		A	3-18				3/1/78	-		
		B	22-42	2/9/78	7.1	1.3	3/1/78	<1.8 (d)	4/13/78	< 1.6
		C	88-98	1/20/78	2.3	0.3	3/1/78	<1.6	4/13/78	5.1
		D	109-129	2/8/78	5.3	0.9	3/1/78	4.2	4/13/78	2.7
Same as SR-4 except 1700' W for gradient:	SR-3	A	2-11	1/24/78	3.4	0.2	2/28/78	3.5	4/13/78	11
		B	23-43	2/8/78	6.0	2.2	2/28/78	2.2	4/13/78	5.7
		C	77-88	1/20/78	10.1	1.1	2/28/78	<2.5	4/13/78	2.7
		D	100-120	2/8/78	< 2.9	0.9	2/28/78	2.0	4/13/78	< 2.3

* Solids too high for accurate measurement

(a) Radium-226 = 0.7 pCi/l
(b) Radium-226 = <0.1 pCi/l
(c) Radium-226 = 0.1 pCi/l

(d) Radium-226 = 0.3 pCi/l

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Table 3.5-9 Radioactivity in Monitor Wells at Proposed SCCC

Monitoring Purpose	Well Set	Well No.	Depth Range, ft.	Radioactivity, pCi/l						
				Date Sampled	Gross Alpha	Radium-226	Date Sampled	Gross Aloha	Date Sampled	Gross Alpha
Background Data for Proposed Gypsum Stack:	SC-4	A	1-10	1/24/78	9.8	0.4	2/23/78	3.0	--	-
		B	33-43	1/20/78	4.5	0.1	2/22/78	1.9	4/12/78	3.5
		C	64-74	2/7/78	<2.3	0.4	2/22/78	<2.7	4/12/78	<2.1
Same as SC-4 except 100' SW for gradient:	SC-3	A	1-10	1/24/78	<7.0	1.8			--	-
		B	39-48	1/20/78	13.0	4.2	2/22/78	3.5	4/12/78	3.0
		C	109-115	2/27/78	*				4/12/78	*
		D	145-151	2/8/78	*	1.6	2/27/78		4/12/78	10.6
		E	284-294	2/22/78	16.2	3.7			4/12/78	33.9
Background data for Proposed Cooling Pond:	SC-2	A	1.5-7	1/24/78	5.6	0.3	2/22/78	2.7	--	-
		B	28-37	1/24/78	21.5	2.4	2/22/78	3.4(a)	4/11/78	<3.0
		C	110-129	2/7/78	18.0	2.0	2/22/78	4.5	4/11/78	<3.4
Same as SC-2 except 100' SW for gradient:	SC-1	A	1-5	1/24/78	40.5	2.6			--	-
		AA	8-13	2/7/78	28.1	1.5	2/22/78	25.6(b)	4/11/78	4.4
		B	24-34	1/20/78	29.6	7.9	2/22/78	17.3(c)	4/11/78	4.5
		C	100-120	2/8/78	8.9	1.4	2/22/78	3.1	4/11/78	13.4

* solids content too high for accurate measurement

(a) Radium-226 = 0.5 pCi/l
(b) Radium-226 = 4.7 pCi/l
(c) Radium-226 = 4.7 pCi/l

Table 3.5-10 Ra-226 Analysis of Groundwater Samples, Occidental Chemical Company, Hamilton County, Florida

Date Collected	Location	Ra-226 Concentration (pCi/1)
1/28/76	Deep Well #1, old well; Chemical Plant 803'	2.6 ± 0.8
1/28/76	Deep Well #2; Float Plant	< 0.8
1/28/76	Deep Well #3, New Well; Chemical Plant	1.4 ± 0.8
1/28/76	Deep Well #4; Stacker Belt	< 0.8
1/28/76	Potable Well #1; Mine	< 0.8
1/28/76	Potable Well #1; Chemical Plant	2.7 ± 0.8 2.2 ± 0.8
1/28/76	Potable Well #2; Mine	1.3 ± 0.8
1/28/76	Potable Well #2; Chemical Plant	2.5 ± 0.8

Source: Sholtes & Koogler Environmental Consultants (1976)

Table 3.5-11 Radioactivity in Other Wells on the Property

Monitoring Purpose	Well Set	Well No.	Depth Range, ft.	Date Sampled	Radioactivity, pCi/l Gross Alpha	Radium-226	Date Samnled	Gross Alpha
Production Well:	Suw. Plt.	MST	160- 240	1/18/78	2.9	0.4	2/28/78	<1.5
Production Well:	Suw. Plt.	M-1	180-1265	1/18/78	3.4	2.3	2/28/78	<3.1
Production Well:	Swft. Ck.	SCD-1	168- 270	1/18/78	<2.1	0.9	2/23/78	1.9
Production Well:	Swft. Ck. 2	SC-2	180- 800	1/18/78	5.8	0.5	2/28/78	<1.8

Table 3.5-12 Results of Gamma Radiation Measurements for Potential Occupational Hazards

	Summary of Florida Mine or Plant Means(a)			Occidental Chemical Company Chemical Complex (b)		
Area or Operation	NP(c)	Ave(Range), μR/hr		N(d)	Ave(Range), μR/hr	
MINING AND WET ROCK						
Dragline areas	6	5	(4-7)	2	5	(5)
Beneficiation	6	12	(5-39)	20	9	(5-21)
Wet rock storage piles	10	67	(24-87)	5	29	(15-41)
Inside storage tunnels	7	17	(7-30)	6	11	(6-24)
Outside Storage tunnels	7	47	(9-73)	5	12	(8-18)
Wet rock storage bins	4	26	(17-58)	5	14	(11-18)
Office/lab buildings	3	15	(7-31)	14	9	(4-16)
DRY ROCK						
Near dryers	6	23	(10-54)	4	13	(11-15)
Inside dryer control room	4	8	(6-11)	1	6	(-)
Grinding area	7	15	(6-60)	2	8	(6-11)
Dry rock unloading	1	34	(34)	2	14	(14-15)
WET PROCESS PHOSPHORIC ACID						
Inside control room	10	34	(6-232)	3	6	(5-6)
Reactor (inside)	-	-	-	1	125	(-)
Reactor (outside)	-	-	-	3	9	(8-10)
Filter level	10	81	(8-364)	4	7	(6-8)
Around filtrate tanks	5	370	(20-712)	1	12	(-)
Above pan filter	9	240	(49-638)	-	--	-
Other in-plant areas	10	33	(21-80)	-	--	-
Gypsum pile	4	23	(20-27)	1	17	(-)
FERTILIZER PRODUCTION						
Product production	13	10	(6-7)	13	11	(6-21)
Fertilizer storage areas	8	14	(6-28)	5	11	(6-14)
Fertilizer shipping areas	4	13	(6-25)	4	12	(6-21)
Office/lab buildings	7	12	(6-34)	(e)		

(a) Summary data from Prince (1977) may include some data from Occidental Chemical Complex and Mines.

(b) Occidental data from internal report to Occidental Chemical Company from the University of Florida.

(c) Number of plants may include a number of measurements at each plant. Some plants may have more than one facility.

(d) Number of measurements at this facility.

(e) Included in office/lab building data under mining and wet rock category above.

Source: After Prince 1977

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Table 3.5-13 Results of Airborne Radon Progeny Measurements for Potential Occupational Hazards

Area or Operation	Summary of Florida Mine or Plant Means[a] NP[c]	Ave(Range), mWL[d]		Occidental Chemical Company Chemical Complex[b] N[e]	Ave(Range), mWL[d]	
MINING AND WET ROCK						
Dragline areas	7	0.4	(0.1-1.6)	-	-	-
Beneficiation	4	0.7	(0.2-1.3)	-	-	-
Wet rock storage piles	3	1.3	(0.1-2)	-	-	-
Inside storage tunnels	11	96.2	(0.7-960)	13	55	(1.7-200)[f]
Outside Storage tunnels	4	4.9	(0.4-16)	8	2	(0.4-5.3)
Office/lab buildings	4	0.3	(0.1-0.6)	1	0.4	(-)
DRY ROCK						
Near dryers	3	0.6	(0.3-1.0)	-	-	-
Inside dryer control room	2	0.4	(0.3-0.6)	-	-	-
Near Raymond mills	4	0.8	(0.6-1.1)	-	-	-
Inside Raymond control room	4	2.0	(0.6-5.9)	-	-	-
Near Ball bills	1	0.3	(-)	-	-	-
Dry rock loading area	1	0.6	(-)	-	-	-
WET PROCESS PHOSPHORIC ACID						
Inside control room	8	2.4	(0.9-6.0)	1	0.9	(-)
Filter level	7	0.8	(0.4-1.0)	1	0.4	(-)
Around filtrate tanks	2	0.7	(0.5-1.0)	-	-	-
Gypsum pile	4	0.6	(0.2-1.3)	-	-	-
FERTILIZER PRODUCTION						
Product production	1	4.2	(-)	-	-	-
DAP production	3	3.0	(0.8-6.6)	-	-	-
ROP-TSP production	2	1.3	(0.1-2.9)	-	-	-
Fertilizer storage areas	7	4.3	(0.4-13)	-	-	-
Fertilizer shipping areas	3	2.1	(1.1-2.6)	-	-	-
Office/lab buildings	8	0.9	(0.3-2.6)	-	-	-

(a) Summary data from Prince (1977) may include some data from Occidental Chemical Complex and Mines.
(b) Occidental data from internal report to Occidental Chemical Company from the University of Florida.
(c) Number of plants may include a number of measurements at each plant. Some plants may have more than one facility.
(d) For ease of presentation mWL are used, i.e., 0.4 mWL = 0.0004 WL.
(e) Number of measurements at this facility.
(f) Measurements taken prior to addition of forced ventilation.

Source: After Prince 1977

Table 3.5-14 Effect of Operating Status of Radon Progeny Concentrations in Wet Rock Loading Tunnels

Tunnel	N(a)	Operating Ave	(Range)(b) mWL	N(a)	Non-operating Ave	(Range) mWL	Ratio Operating/ Non-Operating
OCCIDENTAL CHEMICAL COMPANY*							
K-2W	1	200	(---)	5	4.4	(1.7-6.6)	46
K-2E	1	210	(---)	4	3.2	(2.4-4.1)	66
K-1	1	200	(---)	1	82.0	(---)	2.4
WEST CENTRAL FLORIDA PLANTS							
G	6	110	(4.8-350)	3	7.9	(2.9-16.0)	14
L	4	94	(13-0.3)	2	34.0	(1.7-70.0)	2.8
E	2	24	(12- 36)	3	12.0	(4.0-17.0)	2.0
H	1	1.2	(---)	7	3.0	(52.0-6.4)	0.4(c)

(a) N = Number of measurements

(b) For ease of presentation mWL are used; i.e., 4.4 mWL = 0.0044 WL

(c) Mechanically ventilated tunnel with ventilation working for both conditions.

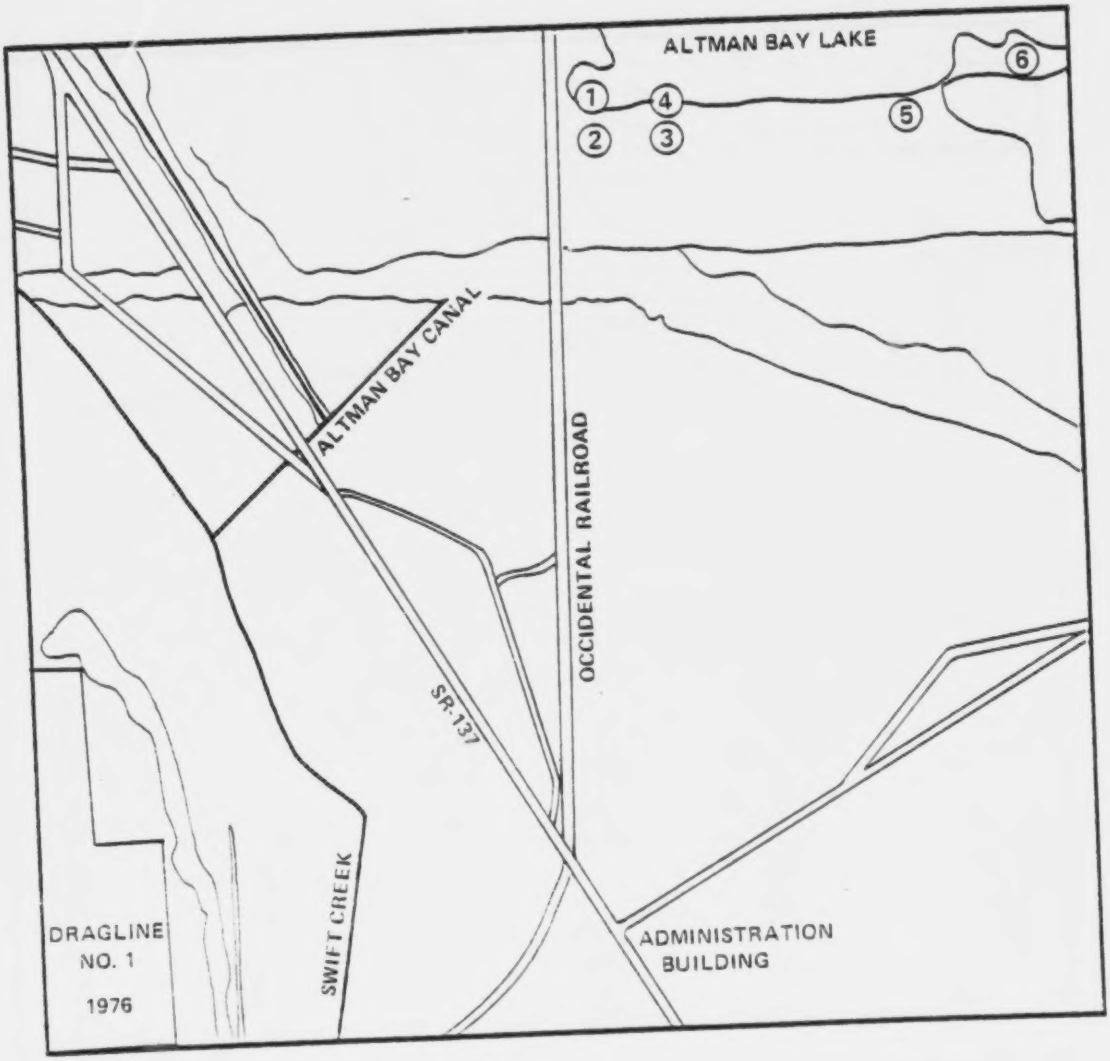
* All tunnels at Occidental have been ventilated since Prince's study.

Source: After Prince 1977

Table 3.5-15 Effect of Mechanical Ventilation on Radon Progeny Concentrations in a Selected Wet Rock Loading Tunnel

	Ventilation Off			Ventilation On			Ratio
Tunnel	N[a]	Ave	(Range), WL	N[a]	Ave	(Range), WL	Off/On
E	2	1.1	(1.0-1.2)	5	0.017	(.004-.036)	65

(a) Number of measurements

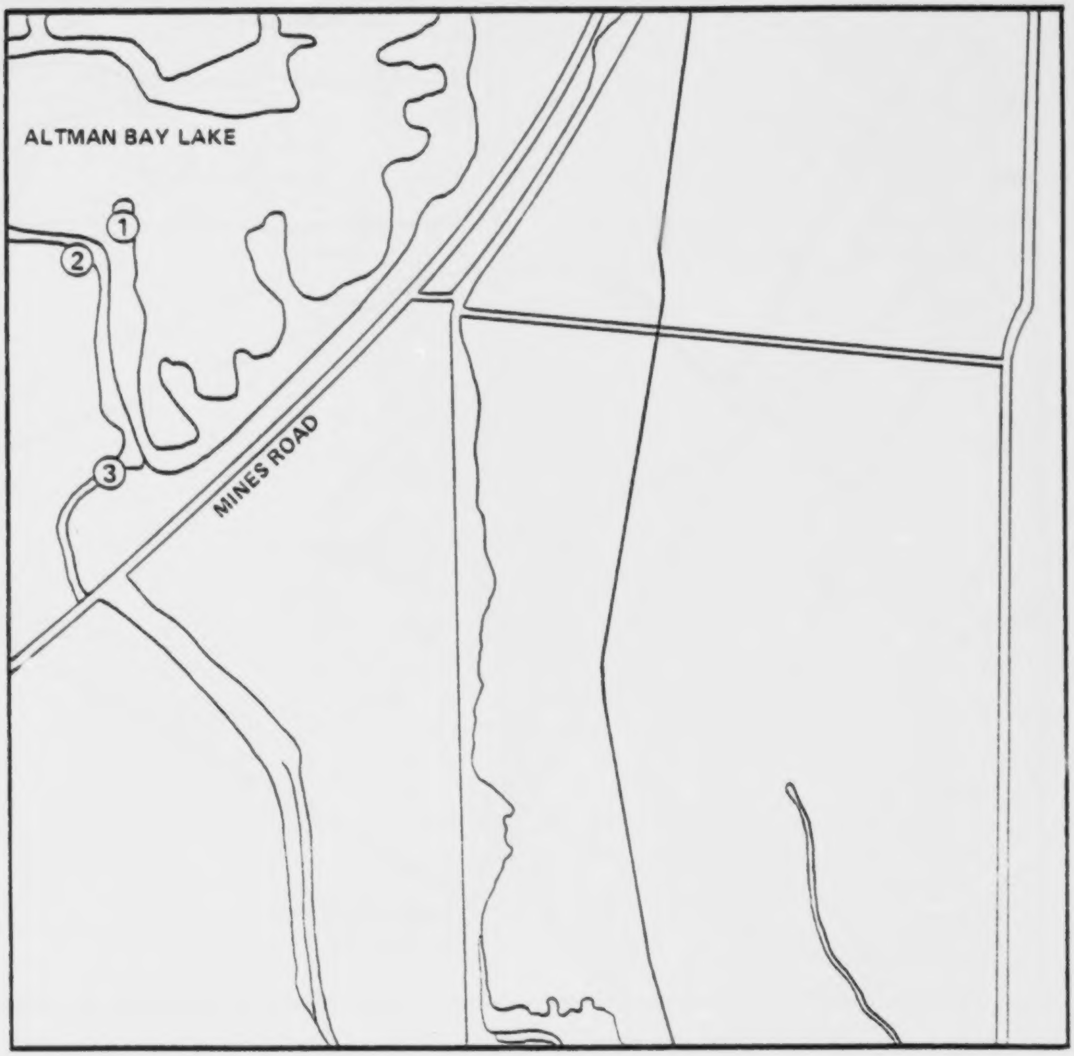

ALTMAN BAY LAKE
①
②
③
④
⑤
⑥
ALTMAN BAY CANAL
OCCIDENTAL RAILROAD
SR-137
SWIFT CREEK
DRAGLINE
NO. 1
1976
ADMINISTRATION
BUILDING

DATE: JANUARY 31, 1976
SECTION: 11
TOWNSHIP: 1S
RANGE: 15E
QUADRANGLE: GENOA

POINT NO.	GAMMA LEVEL (R/HR)	COMMENTS
1	8.3	WATER'S EDGE
2	5.5	
3	6.1	WATER'S EDGE
4	13.9	
5	5.5	
6	10.9	

RECLAIMED LANDS AND PLANT VICINITY—WATER'S EDGE

FIGURE 3.5-1

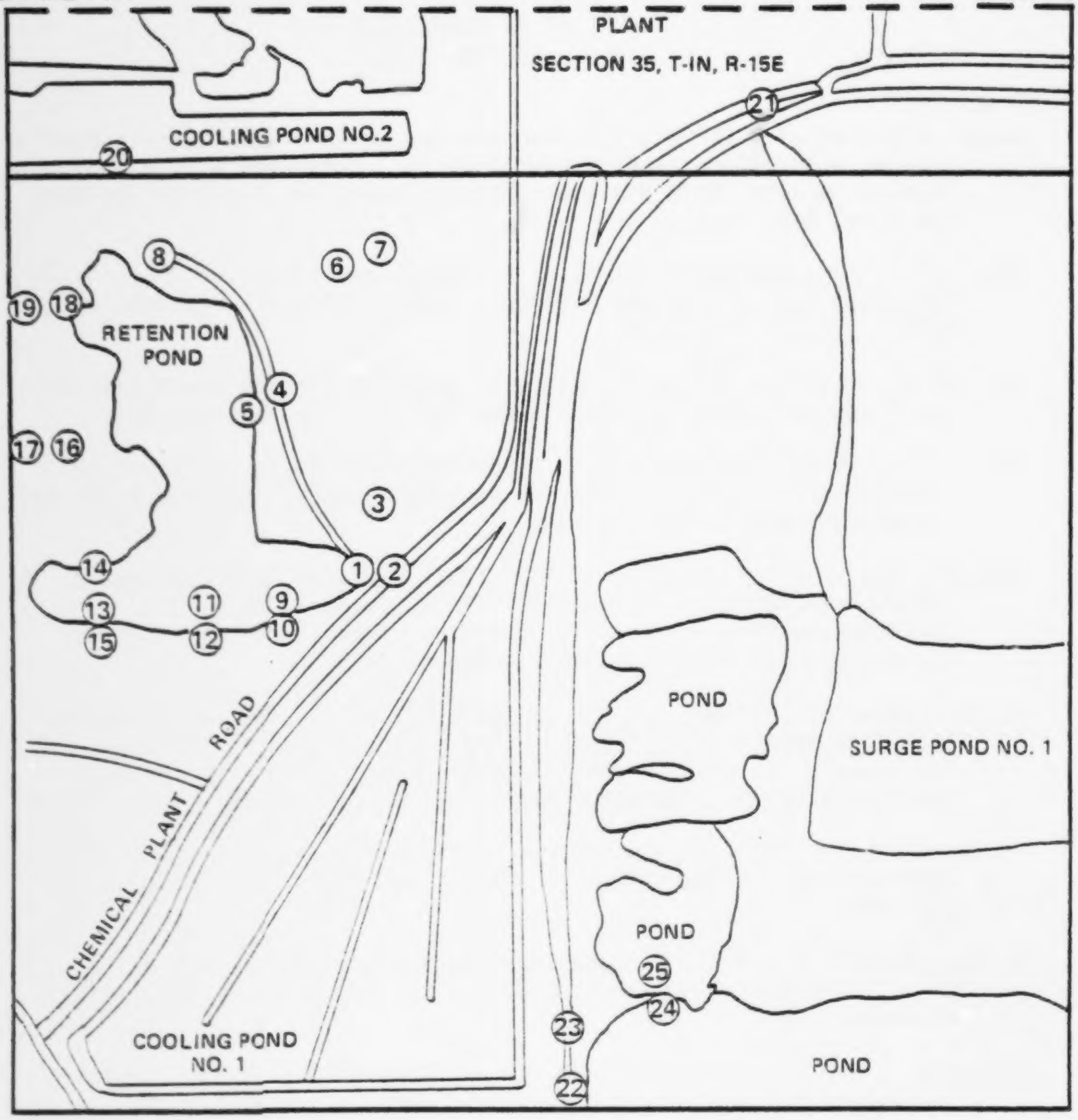

ALTMAN BAY LAKE
①
②
③
MINES ROAD

DATE:	JANUARY 31, 1978
SECTION:	12
TOWNSHIP:	1S
RANGE:	15E
QUADRANGLE:	GENOA

POINT NO.	GAMMA LEVEL (R/HR)	COMMENTS
1	7.2	PARKING LOT
2	9.5	
3	25.1	

RECLAIMED LANDS AND PLANT VICINTY–PARKING LOT

FIGURE 3.5-2


PLANT
SECTION 35, T-IN, R-15E
COOLING POND NO.2
RETENTION POND
CHEMICAL PLANT ROAD
COOLING POND NO. 1
POND
SURGE POND NO. 1
POND
POND
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

DATE:	JANUARY, 31, 1978
SECTION:	2
TOWNSHIP:	1S
RANGE:	15E
QUADRANGLE:	GENOA

RECLAIMED LANDS AND PLANT VICINITY–PONDS

FIGURE 3.5-3

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(SECTION 3.5)

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SECTION 4.0

ALTERNATIVES TO THE PROPOSED NEW SOURCE

4.1 SITE LOCATION

At least two alternate site locations could be considered in addition to the present proposed Swift Creek site. The plant could be located at the existing Suwannee River Chemical Complex or it could be located at a site on the Mississippi River, which is presently unidentified.

4.1.1 SUWANNEE RIVER CHEMICAL COMPLEX LOCATION

Location of the proposed chemical plant at the Suwannee River Chemical Complex would result in a high concentration of process units with increased air emissions in a small area. There would be a small increase in fluoride, sulfur dioxide, and the sulfuric acid mist air emission in the area.

Additional traffic on the roads to the plant because of the increased number of employees would create a small additional amount of fugitive dust in the area.

A new gypsum stack and acid cooling water pond would be required and it is not possible to expand the existing ponds since the existing ponds are surrounded by mined-out lands. It would be necessary to construct a new gypsum stack and pond about two miles south of the existing No. 1 gypsum stack. This would require pumping gypsum slurry and warm process water two miles to the new pond and returning cool process water two miles back to the plant. This long distance pumping requirement would result in increased electrical energy consumption, increased potentials for occasional pipeline leaks and spills of gypsum slurry and process water, and a substantial capital and operating cost increase. The cost of spill control programs, because of the long distances involved, would be high.

Consideration of the environmental and economic factors leads to the conclusions that this is not a realistic alternative.

The socioeconomic impacts of expansion of the facilities at the site of the existing plant will be the same as at the Swift Creek site. That is, if the new plant is built on the site of the existing Suwannee River complex, the income, employment and other socioeconomic impacts will be precisely the same as if the plant is build at the Swift Creek site.

4.1.2 MISSISSIPPI RIVER LOCATION

Location of the chemical complex on the Mississippi River would involve shipment of unit train loads of phosphate rock from the existing Swift Creek Mine to the river site. This would greatly increase the cost of product SPA because of the freight rates involved in shipping a low grade P_2O_5 material. Railroad tonnage for the rock would be 2.5 times that required to ship SPA to the Jacksonville plant. This would require considerably more energy for the railroads because of the increased tonnage and greatly increased distance. In order to reduce freight rates, it would be necessary to dry the phosphate rock rather than ship wet rock with 10 or 12 percent moisture. This would increase particulate and SO_2 emissions from the dryer at the Swift Creek Mine site, plus increased energy consumption for dryer fuels and electric power. Loading of dry rock would increase fugitive dust emissions at the Swift Creek Mine and unloading of the dry rock at the Mississippi site would result in some fugitive dust emissions.

Gypsum stacking in Louisiana requires that gypsum stacks be lower in height due to the poor characteristics of the Louisiana soil as compared to the proposed Swift Creek Chemical Plant site. The acreage required for gypsum stacking might be more than double that required at the Swift Creek location. This greatly increases the ratio of rainfall to solar evaporation area in the gypsum stack and cooling pond system and increases the amount of process water which would have to be treated and discharged. In the Louisiana area, the most probable site, the annual rainfall is about 65 inches per year compared to the Florida Swift Creek location of about 45.5 inches per year. Solar evaporation is about the same as Swift Creek, 50 inches per year. Existing phosphate chemical plants in Louisiana find it necessary to continuously neutralize and discharge large volumes of treated process water because of the large imbalance between rainfall gain and evaporation loss. The Swift Creek site would have a negative water balance in the pond system and it is expected that process water would be treated and discharged about one month every 5 years.

The location on the Mississippi would allow direct loading of superphosphoric acid into the ocean-going vessels used for transport to

Russia and it would not be necessary to have unit SPA trains from the proposed Swift Creek site to the Jacksonville port. The distance to the port is a fairly short haul from Swift Creek and the probability of spills or leaks along this route are very minimal, based on many years past experience, in shipping superphosphoric acid by rail throughout the U.S.

Consideration of the environmental effect of continuously discharging large volumes of treated process water, enlarging the land area for gypsum stacks, the increase in particulate and sulfur dioxide emissions, greatly increased fuel and electric power consumption, greatly increased railroad tonnages on already crowded and old rail lines, and the greatly increased cost for product due to rail freight charges, leads to the conclusion that this is not a practical plant site.

4.1.3 ENVIRONMENTAL FACTORS

4.1.3.1 Comparison of the Two Sites with Respect to Aquatic Communities

No significant impact on the aquatic communities in the Suwannee River and Swift Creek should occur due to the location of the proposed chemical plant. The discharged waters will enter the Suwannee River via the EPA discharge Point 001 on Swift Creek, regardless of the plant's location and the quantity and quality of discharge will be approximately the same for either location. The discharge quality will closely approximate that of the existing chemical complex which has discharged to Swift Creek since approximately 1965; however, if the chemical plant is built at the Swift

Creek site, discharge will flow through Eagle Lake where the longer retention time should result in improved turbidity control.

4.1.3.2 Vegetation: Comparison of the Two Sites

The SCCC expansion site alternative would be an addition to the SRCC located to the immediate east of the existing Suwannee River Chemical Complex. Part of the existing Polyphos pond would be filled and the new plant constructed in its vicinity. Total land area utilized would be approximately 40 percent less than that anticipated for the Swift Creek Chemical Complex since existing cooling ponds could be used to a large extent (Occidental Staff, personal communication). Construction impacts to vegetation would therefore be less than that anticipated from the proposed Swift Creek area.

Operational impacts to vegetation would be identical to those assessed for the Swift Creek area since discharges of water would still be routed through Swift Creek. Impacts associated with air emissions may be greater at the SRCC expansion site since discharge points of the existing facilities and the proposed new sources would be located at the same point and would therefore increase concentrations of fluorides, sulfur dioxide and acid mist. An increased probability of impacts on vegetation resulting from plant upsets would be likely since all sulfuric plants would be located in the same area.

4.1.3.3 Faunal Comparisons of the Two Sites

The area comprising the proposed site for the Swift Creek Chemical Plant and the alternative site at the existing chemical complex (Section 4.1) is generally, highly disturbed. This results in a low species diversity and an increased abundance of certain groups of animals such as generalist rodents and wading birds. Because there will be minimal impacts resulting from construction, and because the discharge of nonprocess waters will not result in degradation of water quality (Sections 3.2.3.2.2, 3.2.3.3.3 and 3.2.3.4.2), and considering the existing fauna on the Suwannee Chemical Complex mine site and Swift Creek watershed (Section 2.7.3.2 and 2.7.4.3), the use of the alternative site would also involve minimal impact. Use of the alternate site would not significantly modify either water quality or discharge (Section 4.1.3.1). The alternative site would require 40 percent less area (potential habitat) than that required for the proposed Swift Creek site; however, there isn't any apparent significant difference between the impacts due to the degraded nature of the habitat in both areas.

4.1.4 ALTERNATE ROUTES FOR DISCHARGE OF NONPROCESS WATER, RAINFALL RUN-OFF AND TREATED PROCESS WATER

Three alternate routes (Figure 4.1-1) for water discharge from the Swift Creek Chemical Plant are possible, each of which is described below.

4.1.4.1 Alternate 1

Nonprocess water and rainfall run-off would leave the chemical plant to a surge pond 10 acres in size and 10 feet deep. From the surge pond, flow would be routed east, past the north side of the process water settling pond. Treated process water (when discharged) would leave the northeast corner of the current No. 2 settling area which will be modified for use as a new settling area for treated process water, and join the nonprocess water and rainfall run-off. Flow will then be routed to the east, then south to the northwest corner of Eagle Lake. Eagle Lake would discharge at Point 001-18 and then into Swift Creek at Point 001.

4.1.4.2 Alternate 2

Nonprocess water and rainfall run-off would leave the south end of the chemical plant and enter the west side of settling area No. 1 and eventually mix with the mine water. Treated process water would leave the south side of the settling area into mine settling area No. 2. Overflow from the south side of the mine settling area No. 1 would flow due east through an existing canal to Eagle Lake.

This alternative could result in process problems in the flotation circuit of the beneficiation plant if the pH of the treated process water adversely affects the pH of the mine water. A violation of the very strict Florida DER standards for phosphorus levels in mine discharge water might occur by discharging treated process water to the mine circuit; therefore, this routing could be unacceptable.

4.1.4.3 Alternate 3

Treated process water (when discharged), nonprocess water, and rainfall run-off, would leave the chemical complex and flow north along the west side of the tailings disposal area; then east to the northeast corner of the tailings area, then south to connect with the canal described in Alternate I, and thence to Eagle Lake.

Note that each alternative enters Swift Creek at discharge point 001 (Figure 4.1-1). Therefore, differences in impacts associated with any alternative would occur above entry to the Eagle Lake retention system and Swift Creek.

From a terrestrial viewpoint alternatives 1 and 2 offer the least potential for impact to vegetation since flow would be routed through channels. Alternative 3, which flows adjacent to Swift Creek Swamp, might cause tree stress to the vegetation of portions of the swamp if discharge water high in sulfates were to regularly or continually overflow into the swamp area. Swamp waters are characteristically low in dissolved oxygen creating a highly reducing chemical environment. Sulfates exposed to the environment could be reduced to hydrogen sulfide which would in turn accumulate in the sediments and water. Even low concentrations of hydrogen sulfide are known to be toxic to vegetation and aquatic animal life.

4.2 PRODUCT

The current proposal envisions a shipment of liquid superphosphoric acid (SPA) to the U.S.S.R. Assuming that this client could accommodate the product, it is possible that a solid fertilizer product such as granular triplesuperphosphate (GTSP) could be shipped to Russia instead of SPA. Production of GTSP at the Swift Creek site would require installation of a GTSP plant which would require large quantities of dry ground phosphate rock. This would increase SO_2 and particulate emissions from the Swift Creek Mine dryer and increase fuel and electric power consumption. A new grinding circuit which would be required either at the mine or at the chemical plant would result in increased particulate emissions and increased electrical power consumption. The GTSP plant would increase the amount of electrical power required at the complex site and would require storage of a large quantity of granular triplesuperphosphate in storage buildings. Fluoride emissions would increase due to emissions from the GTSP stacks and the stacks from the vented storage building.

Freight costs to the port would be considerably higher per unit of P_2O_5 transported since the GTSP is only 46 percent available P_2O_5 whereas the SPA would be 70 percent. The tonnage hauled by the railroads to the Jacksonville port would increase by 52 percent. Fugitive dust emissions would increase due to loading operations at the plant and unloading, storing, reclaim, and vessel loading at the port. Economic considerations would depend upon a new contract that would have to be negotiated with U.S.S.R., assuming that this is possible. Since the U.S.S.R. is currently investing millions of dollars in constructing new liquid and solid fertilizer plants to use the SPA from Occidental, this possibility is extremely remote.

Consideration of the increased emissions of fluorides, particulates, increased fuel and electrical power consumption, increased freight costs, and the very remote possibility of renegotiating the Occidental-U.S.S.R. contract, leads to the conclusion that this is not a desirable or practical alternate.

4.3 PROCESS ALTERNATIVES

4.3.1 PURIFICATION PROCESS ALTERNATIVES

No alternatives for the clarification process leading to SPA are being considered by Occidental.

4.3.2 ULTIMATES DISPOSAL OF TREATED EFFLUENT

Four major alternatives for ultimate disposal of treated effluent were evaluated on a preliminary basis for the purpose of this study: Land Application, Deep Well Injection, Reuse, and Surface Discharge. These alternatives are discussed in the following section.

4.3.2.1 Land Application

Evaluation of the land application technique involved consideration of the following design criteria: Application Methods, Water Characteristics, and Storage Requirements.

Based on the findings of this study, land application by spray irrigation was concluded unsuitable for ultimate disposal of second stage effluent. Rejection of this alternative was based on limitations such as excessive amounts of sodium, sulfates, chlorides and dissolved solids in the treated effluent and excessive storage requirements during the rainy season.

Specific problems associated with waste characteristics, available site features, and storage requirements are described in the following discussions.

4.3.2.1.1 Land Application Methods: The three basic land application methods are irrigation, infiltration-percolation, and overland flow, each suited to different conditions and adaptation to different objectives. For evaluation of ultimate disposal of Occidental's water, irrigation by spraying was chosen for study. A discussion of these methods and the features of the available sites will explain this choice.

Irrigation renovates water by employing the natural mechanisms of the plant-soil complex and eliminates the need for surface discharge. Nutrients are removed by plant uptake while other pollutants are removed by the physical, chemical and biological action within the soil. Best results are obtained with a neutral soil pH condition.

Typical application rates range from 1-3 inches per week for use in crop production to 2.5-4 inches per week when hydraulic maximization is required. Water applied is either lost to evapotranspiration or to groundwater percolation. A 5-foot depth to groundwater level is required. Suitable sites should have loamy soil, but sandy to clay soil may be acceptable.

For overland flow application, water to be treated is applied as a sheet flowing across a sloped, vegetated surface of clay or clay-loam soil. Renovated surface run-off is then collected by ditches for discharge. This technique is generally used for polishing or as an advanced treatment process.

Treatment provided by the soil system is relied upon totally in infiltration-percolation land application. Water is applied at high rates to the site by means of a basin or other containment techniques. Most of the applied water is transferred to groundwater while some is lost to evaporation. A highly permeable soil, such as sandy loam, sand, or gravel, is necessary, and a 15-foot depth to groundwater is required. One objective of this technique is direct groundwater recharge. Therefore, the quality of water which reaches groundwater must usually be of drinking water standards.

No presentation is made concerning the geology of the site. The topography of the potential sites is nearly level and presents good conditions for spray irrigation in this respect. Such conditions present little erosion hazard from irrigation and probably facilitate good system management.

Provided that drainage limitations can be overcome, spray irrigation is the only land application method worthy of consideration for meeting the disposal objectives and for adaptation to the potential site. This method involves the use of a plant system which provides the uptake mechanism necessary for nitrogen and phosphorus removal. A hardy grass cover crop less susceptible to damage resulting from exposure to water constituents would be required for such a system.

4.3.2.1.2 Water Characteristics: The suitability of water disposal by spray irrigation, in terms of constitutent loadings, can be appraised by comparison of the pertinent characteristics with that of water successfully applied to land treatment systems or by comparison to irrigation water quality criteria. Although termed as a disposal technique in this situation, land application renovates water which either enters groundwater or is recovered. Pollutants are retained or utilized by the system. Maintenance of the system requires careful control of the water applied, particularly in terms of constituent loadings. These discussions will address the compatability of second-stage effluent to spray irrigation in terms of the pertinent characteristic parameters.

Land application in the form of a spray irrigation system with a forage crop cover is assumed for this discussion.

Typical municipal waste applied to land contains about 20 mg/l total nitrogen. With anticipated nitrogen levels the spray irrigation system should not be limited by nitrogen loading rates; however, use of a forage crop with high nitrogen uptake may be desirable. Coastal Bermuda grass, for example, has a high nitrogen uptake of 480-600 lbs/acre/year.

Maximum recommended concentration of fluoride for use in soil treatment systems is 15 mg/l for an application rate of 36 in./year for water used up to 20 years on fine textured soils of pH 6-8.5. For higher application rates the recommended maximum concentrations decrease accordingly. Therefore, the level of fluoride in second-state effluent would require an application rate of considerably less than 36 inches per year.

Total phosphorus levels as high as 16 mg/l were found in some land-applied municipal wastewater and the level found in the second-stage effluent is not considered to be prohibitive. The plant-soil complex's ability to remove phosphorus would probably be greatly exceeded by any application containing phosphorus levels higher than that expected in the second-stage effluent.

Excessive amounts of sodium are present in second-stage effluent and would be prohibitive to any land application system possible. The sodium, calcium and magnesium levels of the water are such that deflocculation of the soil structure, and thus, decreased permeability could result. In addition, such levels found in the second-stage effluent (sodium - 1000 mg/l) would be deleterious to the plants sprayed.

Soils cannot remove dissolved solids from water permanently. These constituents are either built up in the soil mantle, requiring a leaching period, or passed through to the groundwater directly, requiring collection of treated water. Industrial waters with total dissolved solids as high as 1500 mb/l have been treated by land application systems but the total dissolved solids of second-stage effluent exceeds that by a factor of more than two. Literature surveys report that concentrations of dissolved solids greater than 2100 mg/l would be unsuitable under most conditions.

Irrigation waters with sulfates in excess of 500 mg/l are generally termed as hazardous. The 2700 mg/l level in the second-stage effluent is, thus, prohibitive.

Levels of chlorides from 100-200 mg/l such as found in the second-stage effluent can be harmful for certain plants. A concentration of less than 100 mg/l will normally not be deleterious for irrigation use.

4.3.2.1.3 Climate and Storage Requirements: Water quantities requiring treatment/disposal and operation of the land application system are determined by rainfall/evaporation. The biggest problem presented by use of land application, besides the water character, is the management of the system. Rainfall events halting irrigation because of potential run-off generation will also produce water, resulting in storage requirements.

Since unfavorable days for land application occur in the rainy season (i.e., when treatment is required), storage of treated effluent must be provided. The minimum effluent storage volume would be required if treatment is conducted only on days favorable for land application, which is not considered feasible.

4.3.2.1.4 Conclusions: Investigation of land application as an alternative disposal technique has revealed that major obstacles must be overcome before it can become a feasible alternative. Based on these investigations, the major objections to the alternative are excessive amount of objectionable constituents in the treated water (with regard to land application) and excessive storage requirements due to the simultaneous occurrence of treatment and unsuitable climate conditions for application.

4.3.2.2 Deep Well Disposal

Deep well injection was investigated as an alternative method for ultimate water disposal. The historical development of this technique, risks and precedents, and the applicability of deep well disposal at Occidental Chemical are discussed in this section.

4.3.2.2.1 Historical Development: Underground effluent disposal in Florida had its beginnings in Orlando in approximately 1904, with the drilling of a well into the Floridan Aquifer to relieve flooding in a low area previously drained by a sinkhole. The success of this early venture led others to copy this solution for areas with excess of water. By 1940, many areas in central Florida were using this means of disposing of excess fluids, generated by their man-made activities.

These early underground disposal practices were characterized by doing the most expedient course of action, sometimes with little regard for protection of water resources. Not unexpectedly, the pollution of underground waters, due to these practices, became a problem and in the 1940's the State began regulating underground disposal. By the mid-1950's, guidelines had been developed which attempted to restrict disposal in the Orlando area to the upper level which had already been extensively polluted, reserving fresh water strata for water supply. Elsewhere, disposal was to be limited to strata containing nonpotable water. Later a lower limit of 1500 mg/l chloride was established for disposal zones in south Florida, and this strategy was at least partially successful.

Since 1965, about 40 injection wells have been completed in the state, or are in various phases of final design and construction. Almost all of these wells inject municipal sanitary waste. In 1966, two disposal wells were drilled at Sugar Cane Growers Coop - Quaker Oats Company plant at Belle Glade. These wells were designed to discharge into cavernous limestone, thus avoiding the plugging problems experienced in other disposal wells in south Florida. These wells were completed in the brackish water part of the Florida Aquifer, in accordance with the

1500 mg/l minimum chloride limitation for injection zones. The 1500 mg/l minimum chloride level statutory regulation was raised informally first to 5000 mg/l and later to 15,000 mg/l.

Federal and State environmental legislation in the late 1960's and early 1970's resulted in a high degree of interest, since underground disposal was a means of meeting effluent limitations. A surge of interest in underground disposal occurred in 1973, when the EPA released their Environmental Impact Statement on waste disposal alternatives in southeast Florida. In this document, underground disposal was recognized as a feasible alternative disposal method for treated water in Dade, Broward, and Palm Beach Counties. As a result, underground disposal of industrial water has also increased with new systems in the planning or construction stages at Pensacola, Belle Glade, and Fort Pierce.

4.3.2.2.2 Problems and Risks: Each application, or potential application, has associated with it a particular set of problems and risks, dependent upon the geologic situation and the nature and volume of the fluids to be disposed. Acceptance of the level of risk depends upon the certainty of confinement of the waste to the disposal zone, and whether or not the socioeconomic benefits offset the degree of risk involved.

The problems and risks associated with underground disposal of industrial wastes are much the same as those associated with municipal water disposal, with additional considerations resulting from the composition of the waste. Regulatory problems arise because current limitations on treatment requirements for underground disposal are written around municipal water requiring secondary treatment. Industrial wastes which are being disposed, or have been proposed for underground disposal, in Florida range from warm, fresh water, through salt water, and to the mix of organic and inorganic acids of varying concentrations. These wastes are generally not susceptible to biological treatment to the degree required under the regulations, leading to a somewhat confusing situation.

For industrial wastes, special design and construction problems are encountered in selecting materials of construction. When the injection fluid is acidic, casings must be cemented in place with acid resistant cement. Stainless steel injection liners are used when corrosion resistance is required. More exotic metals, or nonmetallic materials, must be used where high chlorides are present and stress corrosion of stainless steel is a problem.

High pressure injection into a relatively "tight" zone might be more economically attractive to an industrial user than some other alternative disposal method, but could present an unacceptable level of risk to the water resources.

4.3.2.2.3 Precedents: In addition to the development of deep well injection as an ultimate disposal technique, regulatory tendencies in recent years are of interest. As stated previously, the great majority of deep wells in Florida inject municipal sanitary waste. Currently only two industrial installations have permits to operate: Quaker Oats Co. in Belle Glade (approved in 1966), and Kaiser in Mulberry (approved in 1973). Monsanto in Pensacola has had an injection well in operation since 1963, although no operating permit has been issued.

Two other industrial installations have been approved for construction and are currently in testing programs: Exxon in northwest Florida (approved in 1972), and American Cyanamid in Pensacola (approved in 1973). One installation, Hercules at Fort Pierce, is now in the proposal stage.

One of the injection wells, disposing of an acidic waste from phosphoric acid manufacture, has experienced problems due to the waste reacting with the strata and causing a "cavern" effect. Injection of a non-reacting buffer fluid, such as diesel oil, has been attempted to protect the upper strata; however, this installation will most likely be plugged when the cavern reaches limiting dimensions, based on the structural integrity of the strata.

In most recent applications, regulatory agencies have required two injection wells at each site, although there are no corresponding statutes for this requirement.

4.3.2.2.4 Applicability of Deep Well Disposal: A review of existing geologic data was conducted to determine the potential technical feasibility of deep well disposal of liquid waste streams from the Occidental Chemical Company White Springs Plant. Our evaluation is based upon a wastestream having the following characteristics.

Rate of flow:	2,000 gpm
Total Dissolved Solids:	2,000 mg/l
Fluoride:	25 mg/l
Phosphorus:	35 mg/l

The scope of this evaluation was to identify possible suitable injection zones beneath the freshwater aquifers in the area. Two factors were considered in making our evaluation: the regional geologic setting and the site-specific data from petroleum exploration wells in the general area. The latter data consists of drilling logs and geophysical logs.

There are three basic requirements for a suitable waste injection zone.

1. The injection zone must be permeable enough to receive the effluent for the required time at a safe and economical injection pressure.

2. The injection zone must be bounded above and below by relatively impermeable confining layers to prevent contamination of groundwater supplies or other natural resources.

3. Injected waste, native water, and injection zone rock must be chemically and physically compatible so the effectiveness of the system will not diminish by chemical and physical changes.

The injection pressure necessary to emplace fluid underground depends upon the volume of fluid injected and the hydraulic characteristics of the receiving zone. The feasibility of deep-well injection is related to injection pressure in two ways.

1. The operation cost (pumping cost) increases with pressure.

2. Pressures high enough to cause fracturing of the aquifer rock must, in general, be avoided.

At the relatively shallow depths of injection indicated by the existing data (2,000 to 3,000 feet), the fracturing pressure is the most significant parameter.

There are no specific data available on fracturing gradient in the study area. Published studies have suggested a safe value of about 0.55 pound per square inch per foot of depth. Assuming an injection depth of 2,500 feet, the safe injection pressure above bottom-hole hydrostatic pressure would be 300 psi.

The calculated minimum receiving zone transmissivity to allow long-term injection at a pressure of 300 psi above static is 2,000 square feet per day (ft^2/day), assuming a storage coefficient of 5×10^{-4}. However, it is estimated that a receiving zone transmissivity of 4,000 ft^2/day or more would be required to ensure the success of deep-well injection.

There are no specific data on the transmissivity and storage coefficients of aquifers beneath the Floridan aquifer in the study area. With the exception of the Boulder Zone in south Florida, transmissivity of the deeper zones has been found to be relatively low but generally within the range of feasible values (2,000 to 5,000 ft^2/day).

4.3.2.2.5 Regional Hydrogeology: Columbia County is situated in the northern highlands of peninsular Florida. This area is characterized by continuous highlands cut by several river systems. These highlands are the northern termination of the predominantly carbonate and evaporitic deposits of peninsular Florida and the eastern limit of predominantly caustic deposits of the Panhandle. The nose of the Ocala uplift is south of the site and the axis of the peninsular arch is to the east. These structural and depositional factors combine to make the depth to Paleoscene and Cretaceous deposits less than in peninsular Florida.

Three separate, but interacting, freshwater aquifer systems are known in the study area. These are the surficial aquifer, the secondary artesian aquifer, and the Floridan aquifer. Deeper aquifers containing saline water may be present in the area but have not been specifically identified.

The surficial aquifer occurs in the shallow sands and the Alachua Formation. It is an easily tapped source of potable water and is typically low in chlorides but high in iron and organic color. This aquifer generally extends to about 30 feet below land surface.

The Floridan aquifer is the primary source of water supply in the study area. The exact vertical extent of this aquifer is unknown in the area, but it extends to a depth of at least 1,300 feet. It encompasses the Suwannee Limestone, the Ocala Group, the Avon Park Limestone, the Lake City Limestone, and possibly the Oldsmar Limestone. The base of the Floridan aquifer is probably the gypsiferous dolomite occurring near the bottom of the Oldsmar Limestone.

The gypsum-impregnated beds in the Oldsmar Limestone and the underlying Cedar Keys Limestone probably isolate the Floridan aquifer from deeper strata.

Aquifers which may be present beneath the Floridan constitute the target injection zones which are the subject of this study.

The possibility of finding a zone with a transmissivity higher than the calculated minimum of about 2,000 ft^2/day exists in several rock units. Drillers' logs and electric logs indicate a zone of possible high transmissivities at about 1,500 to 1,900 feet in the Cedar Keys Limestone and dolomite and possibly in the upper beds of the Lawson Limestone. The dolomites are hard and usually fractured, with solution cavities forming along the openings. Where extensive cavity systems are developed, transmissivities greater than 100,000 gpd/ft are common.

At a depth of 2,150 to 2,600 feet in the Lawson Limestone another zone possibly having the required characteristics is indicated on drillers' logs and geophysical logs. Potential injection zones in this interval occur in hard dolomite strata 200 to 300 feet below the top of the formation and below the first evaporites (gypsum and anhydrite).

As outlined in the requirements for injection zones, the presence of adequate confining beds is a necessity for successful injection.

Above the Cedar Keys, the Oldsmar may contain potable water. It would be necessary to contain the waste within several hundred feet if the 1,500- to 1,900-foot zone were used. There are dense dolomites and limestones present, but their thickness and areal extent are unknown from present information. The upper beds of the Lawson would serve as aquitards for injection into the 2,150- to 2,600-foot zone.

4.3.2.2.6 Conclusions: The target zones for deep-well disposal at the Occidental Chemical White Springs Plant would be the Lower Tertiary and Upper Cretaceous Limestones and dolomites. Potential injection zones are indicated on drillers' and geophysical logs between 1,500 and 1,900 feet and between 2,100 and 2,600 feet in depth. Of these two intervals, the 2,100- to 2,600-foot zone is the most promising.

In the course of this study, no specific data were found directly relating to the transmissivity of the target injection zone. The target zones were identified by certain key words such as "lost circulation," "broken and fractured," and "honeycomb lime" in drillers' logs, and by permeability implied from electric and sonic logs. Experience has shown that these are reasonable, but not infallible, indicators of permeability.

The overall outlook for this disposal alternative in this case is not especially favorable. The presence of a suitable injection zone is problematical. None of the data presently available strongly suggests that such zones exist. Definitive answers as to the viability of deep-well injection/disposal are not readily available. Variable geologic conditions and the uncertainty of regulatory requirements prevent ironclad reasoning without an extensive and costly testing program.

Acquisition of such data would require the drilling of a test hole to a depth of 3,000 feet, at a cost probably in the range of $600,000, to determine accurately the feasibility and to assess the environmental impact of deep-well injection. It is likely that treatment to BPT established 1977 limits would be required; thus, the costs of deep-well exploratory drilling and facilities construction, which may cost as much as $2.5 million, would be in addition to the cost of treatment facilities.

For these reasons, and considering the expected infrequency of process cooling pond water treatment, we would recommend further development of deep-well injection as a disposal only if all other available disposal methods are economically and/or environmentally unacceptable.

4.3.2.3 Water Reuse

Reuse of raw and/or treated process water can significantly reduce the volume of waste which requires treatment and disposal, and, consequently, reduces the costs of treatment and the environmental impact of discharged water. In addition, the quantity of makeup water drawn from wells can be reduced.

The potential for reuse varies greatly in the phosphoric acid industry due to varying quality of makeup water, quality variations in phosphate rock, limitations based on existing materials of construction, and the use of different production processes and operating philosophies.

Since extensive water conservation and reuse will be designed into the Swift Creek Chemical Complex, implementation of further reuse is limited due to the following process difficulties.

1. Additional recycle of nonprocess water is limited by the concentrations of dissolved constituents, since the majority of the water is used for cooling. Excessive dissolved constituents (hardness, chlorides, sulfates, etc.) cause corrosion and/or fouling of heat exchangers, cooling towers, and related process equipment.

2. Reuse of nonprocess water for process cooling water makeup can only be practiced during periods of the year when evaporation exceeds rainfall. Even then, the quantities of makeup required are only a fraction of the nonprocess stream.

For these reasons, additional reuse does not presently appear to be feasible. Continuing technology development may be expected, however, with resultant improvements in water balances and further reductions of treatment and disposal requirements.

4.3.2.4 Surface Discharge

Surface discharge of treated process water is the most feasible and economical ultimate disposal alternative. Two-stage lime treatment will consistently achieve EPA discharge effluent limitations and permit requirements of the Department of Environmental Regulation, State of Florida.

An important consideration of surface discharge is that disposal of treated process water will only be required for an estimated period of one month every five years, and that periods of discharge will coincide with relatively high flows in receiving streams due to seasonal rains. Therefore, the impact to the environment will be minimized.

As discussed previously, nonprocess water is generally suitable for direct surface discharge; thus, alternative disposal techniques were not evaluated. Extensive sampling and monitoring will be provided in order to provide treatment in the event of contamination through emergency or upset conditions, or, when possible, to recycle this stream to process cooling water makeup. Automatic diversion will be provided to ensure containment of any contamination for protection of the receiving stream.

4.3.2.5 Conclusions

Based on the findings of this study and similar investigations of treatment of process water, the following conclusions can be made.

1. The proposed Swift Creek Chemical Complex will generate basically typical process water, which will require treatment infrequently due to hydrologic imbalance, and a minimum of nonprocess water, which is generally suitable for direct surface discharge, even though extensive water conservation and reuse measures will be designed into the facility.

2. Two-stage lime treatment to a pH of approximately 9.0 has proven effective in removal of phosphorus and fluoride to concentrations acceptable for disposal (25 mg/l F and 35 mg/l P), and is the recommended treatment system. Numerous other constituents are also removed effectively. Fluoride concentrations significantly below 25 mg/l cannot consistently be achieved with currently available technology given the existing operating constraints.

3. Treatment of contaminated nonprocess water is proposed to be conducted using the lime treatment facilities, since the occurrence of contamination of nonprocess water and the requirement to treat process water are both very infrequent. In addition, the constituents of any contamination of nonprocess water are very likely to be similar to process water, although probably at much lower concentrations; thus, the lime system is expected to provide effective treatment.

4. Extensive instrumentation will be provided for effective treatment process control, fail-safe alarm systems, and automatic diversion of potentially contaminated nonprocess water either to treatment or to the cooling ponds.

5. Land application and deep-well injection of treated effluent are not considered technically and economically feasible alternatives for ultimate disposal, due to specific limitations of constituents in the effluent, the uncertainty of suitable disposal sites, and, in the case of deep-well injection, the lack of assurance of protection of groundwater quality. These alternatives should only be considered further in the event surface discharge is unacceptable.

4.3.3 HEMIHYDRATE WET PROCESS PHOSPHORIC ACID PROCESS

The hemihydrate wet process for the production of phosphoric acid was an alternative under active consideration by Occidental Chemical Company. A final decision to use the hemihydrate process rather than the dihydrate process has been made. The following material describes this alternative.

4.3.3.1 Chemical Plant Description

4.3.3.1.1 Products

Final products shipped from the Swift Creek Chemical Complex will consist of 70 percent P_2O_5 superphosphoric acid (SPA). SPA will be shipped by rail car.

4.3.3.1.2 Capacity

Total production at the complex will be 350,000 metric tons per year P_2O_5 as SPA. Sufficient sulfuric acid will be produced on-site to satisfy requirements. Phosphate rock will be supplied from the existing Swift Creek Mine (SCM).

4.3.3.1.3 Raw Materials

Sulfur will be supplied by rail car, limestone by truck, and phosphate rock by conveyor belt.

4.3.3.1.4 Process Units

Intermediates and final products will be processed or produced on-site using the proposed facilities which consist of a phosphate rock transport system, one dihydrate wet process phosphoric acid plant, phosphoric acid evaporation facilities, two contact sulfuric acid plants, a phosphoric acid clarification plant, and two SPA plants.

4.3.3.1.5 Support Facilities

Support facilities at Swift Creek Chemical Complex will consist of administrative offices, a central laboratory, a maintenance shop, a supplies warehouse, product storage and shipping facilities, one gypsum stack with associated cooling pond, fuel oil and miscellaneous chemicals storage, electric power substations, electric power generation (60 percent generated using excess process steam), roads, railroads, deep freshwater well, domestic sewage treatment plant, compressed air, interconnecting piping (for raw materials, intermediates, products, potable water, freshwater, cooling water, steam, reagents), a fire water system, and a two-stage limestone-lime treatment station.

4.3.3.1.6 Water Balance

The proposed Swift Creek Chemical Complex will have one 7,000 GPM freshwater well at a depth of about 800 feet.

One 500 GPM potable well at a depth of about 300 feet will supply all potable water uses. Treated domestic water is discharged to the Swift Creek Mine water circuit.

Detail water balances were prepared for each process unit and support facility of the proposed Swift Creek Chemical Complex (Phase II Expansion) at full operation. Occidental Chemical Company's project scope; product slate and tonnages; material balances; process unit operating sequences; raw material, intermediate, and product specifications; performance requirements of air pollution control equipment; sketches of proposed gypsum stacks and cooling ponds; local weather data; and other information was used to develop the detail water balances which are included in the description of each unit or support facility.

An overall water balance is summarized in Figure 4.3-1 and Table 4.3-1 for the Swift Creek Chemical Complex (Phase II) in terms of

MGD (millions of gallons of water per day), based on an operating time of 310 DPY (days per year).

Freshwater requirements are 3.68 MGD (2,556 GPM) and nonprocess water discharge is 1.65 MGD (1,142 GPM). The gypsum stack and cooling pond shows a deficit water balance of 0.07 MGD (51 GPM).

4.3.3.1.7 Water Discharges

The water discharge route is shown in Figure 1.4-3 and is the actual route to be used. Average daily flow (exclusive of rainfall run-off) is 1.49 MGD for 365 days per year.

Nonprocess water discharge (with rainfall run-off) will flow east from the proposed chemical complex site in a freshwater ditch through a nonprocess surge pond of 30 acres. Then it will discharge east and south in the freshwater ditch to Section 10 Pond for final clarification before discharge to Swift Creek at NPDES sampling point 001.

A treated process water discharge is not expected unless excessive rainfall occurs. If discharged, process water would be treated in a two-stage neutralization system using limestone and lime with intermediate settling. Discharge of treated water would then flow from the east end of the settling pond to intercept the freshwater ditch or to the Swift Creek Mine water circuit.

Actual flows at existing sampling point 001 for permit FL-0000655, located in Swift Creek, from January 1976 through September 1977 are shown in Figure 1.4-5. These flows include the SRCC, SRM and SCM discharges plus rainfall run-off. During this period, average flows (based on daily measurements) ranged from 4.0 MGD in May 1977 to 146 MGD in February 1978, with daily flows ranging from zero in May 1978 to 188.5 MGD in March and April 1976.

Nonprocess water will discharge to a freshwater ditch in the chemical plant, which discharges to a nonprocess surge pond, which discharges to a second freshwater ditch, which discharges to the Section 10 pond, which discharges to Swift Creek. Prevention and control of contamination of nonprocess water will be accomplished in several ways.

First, all acid process and storage areas will be curbed, and separated from nonprocess waters and rain run-off areas. Acid leaks and spills will be collected and returned to the process or to the process wastewater (pond water) system.

Second, any point source nonprocess water that could become contaminated by leaks will be pH monitored in each process area on a routine basis and diverted from the first fresh water ditch to the process wastewater (pond water) system until the leaks are repaired and the pH has returned to normal.

Third, nonprocess water that cannot become contaminated and rain run-off from nonprocess areas will go directly by way of the first fresh water ditch to the nonprocess water surge pond. This nonprocess water surge pond will be 30 acres in size, 20 feet deep, and have a retention time of over 100 days except during rainfall periods. Inlet and outlet of the nonprocess water surge pond will be continuously pH recorded and alarmed for low pH levels to assume corrective action.

Fourth, if the pH leaving the nonprocess surge pond becomes too low, the discharge will be diverted to the second stage neutralization station, treated with lime, and settled in a pond.

Fifth, overflow from the settling pond will be discharged back to the second freshwater ditch going to the Section 10 pond for final clarification before discharging to Swift Creek. The Section 10 pond is 150 acres and 20 feet deep and has a retention time of 156 days, except during rainfall periods (based on nonprocess water discharge rate and Swift Creek Mine water discharge rate). This long retention time will allow clarification of the nonprocess and mine discharge water for removal of suspended solids and will dampen out any pH or contaminant changes should all of the first four control actions malfunction, which is highly unlikely.

4.3.3.1.8 Process Water Surge Levels

The proposed ponds are discussed in other sections of this document.

4.3.3.1.9 Permits

Eight Florida air construction permits have been issued for the proposed Phase II expansion at Swift Creek.

4.3.3.2 Description and Environmental Aspects of Proposed Process Units at Swift Creek Chemical Complex

4.3.3.2.1 Sulfuric Acid Plants E&F

Type of Plant: Two sulfur-burning double absorption contact sulfuric acid plants producing 98 percent sulfuric acid, complete with water treatment, cooling tower, oil fired startup heater, and an auxiliary boiler.

Capacity: Nominal capacity of 2,000 short tons per day each, 100 percent sulfuric acid basis; auxiliary boiler, 125,000 lb/hr850 psig, 850°F; fuel will be 0.8 percent sulfur commercial distillate; operation 25 percent of the time.

Raw Materials: Molten sulfur, water, and air.

Storages: (1) 28,000 tons (100 percent basis) 98 percent acid storage in tanks plus one 2,500 ton (100 percent basis) 93 percent H_2SO_4 storage tank; (2) 10,000 tons molten sulfur in storage tanks; and (3) one fuel oil tank with capacity of 9,000 gal.

Air Emissions: Sulfuric Acid Plant E has a Florida construction permit application dated 5-2-77; Plant F has a Florida construction permit application dated 5-2-77; and auxiliary boiler no. 3 has a Florida construction permit application dated 5-2-77. The allowable air emissions according to EPA for plants E&F are 4 lb SO_2/ton H_2SO_4 produced (100 percent basis) and 0.15 lb sulfuric acid mist/ton H_2SO_4 produced (100 percent basis). Auxiliary boiler No. 3 has no visible emission.

Water Discharges: Only nonprocess water is discharged from the plants. Boiler blowdown, cooling tower blowdown, miscellaneous cooling water (consisting of cooling water for bearings, air compressors, air conditioners, and oil lubrication systems) and condensate from the sulfur melting coils are discharged to the freshwater ditch. Water from regeneration of the boiler feed water softeners is discharged to the Swift Creek Mine water circuit adjacent to the Swift Creek Chemical Complex. Table 4.3-2 summarizes water uses and discharges.

4.3.3.3 Phosphate Rock Transport No. 3 (supplies phosphoric acid plant D)

Type of Plant: A conveyor belt from the Swift Creek Mine will be used to handle wet rock to the plant and will discharge to a storage bin at phosphoric acid plant D.

Capacity: One conveyor belt which has a 280 short tons per hour minimum capacity.

Raw Materials: Wet unground 66/69 bone phosphate of lime (BPL) phosphate rock.

Storages: A 2-hour storage bin for wet rock storage.

Air Emissions: No air emissions will occur in the conveying and storage of wet phosphate rock; therefore, particulate collection devices and air permits will not be required.

4.3.3.4 Phosphoric Acid Plant D--Hemihydrate Process

Type of Plant: Wet Process Hemihydrate Phosphoric Acid Plant with one filter, and tank farm.

Capacity: Nominal capacity 1,400 short tons per day P_2O_5.

Raw Materials: Wet unground 68 BPL phosphate rock and 98 percent Sulfuric Acid.

Storages: Two storage tanks for phosphoric acid storage at 28 percent P_2O_5 and 40 percent P_2O_5 with total volume of 800,000 gal.

Air Emissions: Phosphoric Acid Plant D has a Florida construction permit application dated 5-2-77. The allowable EPA and Florida air emissions are: Fluorides at 0.02 lb/ton P_2O_5 input (EPA & Florida) and particulates at 44.8 lb/hr (Florida).

Water Discharges: Only nonprocess water (filter skirt sprays) is discharged. Process water is recirculated from the gypsum stack and pond. Nonprocess water consisting of vacuum pumps seal water, filter skirt sprays, and miscellaneous cooling water consisting of cooling water for air compressors, oil coolers, and air conditioners is discharged to the sulfuric acid plants cooling tower for makeup water. Table 4.3-3 summarizes water uses and discharges.

4.3.3.5 40 Percent-54 Percent Phosphoric Acid Evaporation

Type of Plant: Forced-circulation type steam heated wet process phosphoric acid evaporators.

Capacity: Nominal capacity 1,400 short tons per day P_2O_5 from 40 percent to 54 percent P_2O_5.

Raw Materials: Wet process phosphoric acid.

Storages: Storage tanks with a capacity of 2,700,000 gal. acid.

Air Emissions: No air emissions. Total condenser system used and control equipment not required.

Water Discharges: Process water is recirculated from gypsum stack and cooling pond. Nonprocess water from vacuum pump seals and compressor cooling is discharged to the sulfuric acid plants cooling tower for make-up water. Table 4.3-4 summarizes water uses and discharges.

4.3.3.6 Phosphoric Acid Clarification

Type of Plant: Occidental proprietary process for removal of impurities from wet process phosphoric acid.

Capacity: Nominal capacity of 1,400 short tons per day P_2O_5.

Raw Materials: Wet process phosphoric acid.

Storages: Incorporated into clarification plant design.

Air Emissions: The phosphoric acid clarification plant has Florida construction permits applications dated 5-2-77. The allowable air emission according to the State of Florida are: Fluorides BACT- 0.05 lb F/ton P_2O_5 input = 3.02 lb/hr.

Water Discharges: Only nonprocess water discharged. Process water is recirculated from gypsum stack and cooling ponds. Nonprocess water from vacuum pump seals and miscellaneous water (cooling water for air compressors and oil cooling) is discharged to the freshwater ditch. Table 4.3-5 summarizes water uses and discharges.

4.3.3.7 Superphosphoric Acid Plants C&D

Type of Plant: Forced circulation type steam heated superphosphoric acid evaporators, product storage, and tank car cleaning station.

Capacity: Nominal capacity 1,400 short tons per day P_2O_5.

Raw Materials: Wet process phosphoric acid.

Storages: Two tanks with a total storage capacity of 12,000 metric tons of acid.

Air Emissions: Superphosphoric acid plants C&D have Florida construction permits applications dated 5-2-77. The allowable EPA air emission is 0.01 lb F/equivalent ton P_2O_5 feed.

Water Discharges: Process water is recirculated from the gypsum stack and cooling ponds. Nonprocess water from vacuum pump seal water is discharged to the sulfuric acid plants cooling towers as make-up water. Tables 4.3-6 and 4.3-7 summarize water uses and discharges.

4.3.3.8 Description of Environmental Aspects of Support Facilities--SCCC Gypsum Stack and Cooling Pond

Function: To store by-product waste gypsum and provide cooling for process water (pond water) recirculated to the process units.

Size: For the gypsum pond area and the cooling pond and surge pond areas, total area for rainfall is 550 acres and total wet area for solar evaporation is 240 acres as determined by Ardaman & Associates, Inc., who have made a preliminary design of the ponds.

Capacity: Handles phosphoric acid Plant D, 40 percent-54 percent P_2O_5 evaporation, clarification, superphosphoric acid plants C&D, and SPA storage and shipping.

Water Recirculation: Can vary from 36,000 to 50,000 GPM depending on demand.

Process Water Treatment Requirements: The gypsum stack and cooling pond facility has a negative balance of 51 GPM on an annual average basis; however, seasonal imbalances of excess rainfall over evaporation during a portion of the year may require infrequent treatment and discharge of treated process water. Based on the New Source Effluent Guidelines, the facility must be designed, constructed and operated to maintain a surge capacity equal to the run-off from the 25-year, 24-hour rainfall event. Hydrologic studies have concluded that a treatment rate of 2000 gallons per minute will adequately provide the required capacity to meet this requirement.

The existing EPA Guidelines and proposed EPA Permit (April 28, 1978) allowable effluent limitations are shown in Table 1.4-9.

A chemical analysis of the process water expected for the Swift Creek Chemical Complex, based on Occidental's existing Suwannee River Chemical Complex operation is shown in Table 1.4-10. These values vary widely on a seasonal basis as influenced by the amount of rainfall. Process water chemical analysis varies with the phosphate rock processed and the chemical processes used. There is no typical analysis in the phosphate industry.

Nonprocess Water Treatment Requirements: Nonprocess water discharge at 1,142 GPM, plus rainfall run-off, will normally be suitable for direct discharge at a greatly reduced rate than in past practice, due to extensive water conservation and reuse at the new chemical complex. In the event of contamination of any point source nonprocess water, as discussed in the summary, the discharge will be diverted to the second stage of the neutralization station.

The existing EPA Guidelines and proposed EPA permit (April 28, 1978) allowable effluent limitations are shown in Table 1.4-11.

Nonprocess water may become contaminated with process water, phosphoric acid, sulfuric acid, or rainfall run-off. Experience in the phosphate industry has shown that when contamination does occur, the levels of fluorides, phosphate, and/or sulfuric acid are generally much lower than for process water. Neutralization of contaminated nonprocess water in the process water neutralization system has been practiced successfully for many years by most Florida phosphate companies and the effluent limitations can be achieved.

Application of Two-Stage Neutralization to Process Water: Latest available technology for treatment of process water is generally referred to as "double liming"; although a combination of limestone and slaked lime may be used.

Two-stage neutralization ("double liming") has proven to be the most effective process for treatment of process water and has been established as the best available demonstrated control technology available (BADCT).

(1) Limestone-Lime Combination: A combination of limestone and lime treatment in the first stage, followed by two-stage settling for solids removal, followed by slaked lime treatment in the second stage, followed

by settling, is planned for Swift Creek. A detailed description of the treatment facilities are given in section 1.4.1.3.1.

Water Balance: Detail process water requirement calculations based on planned operation shows a deficit water balance of 51 GPM, 310 days per year operating time.

Nonprocess Water Discharge: There is one chemical plant well with a capacity of 7,000 GPM.

The average well water consumption will be 2,556 GPM, 310 days per year depending upon operations. Resulting nonprocess water discharged to the freshwater ditch will be 1,142 GPM, 310 days per year. The difference between well water use and nonprocess water discharge is due to evaporation in cooling towers, chemical water consumption, steam, stack water, and water entering the process water systems.

4.3.3.9 Domestic Water Treatment Plants

Function: Plant serves office, lab, shops, phosphoric acid Plant D, Sulfuric Acid Plants E&F, 40 percent-54 percent P_2O_5 Evaporation, Clarification, Superphosphoric Acid Plants C&D, SPA Storage and Shipping.

Size: 25,000 gal. design with chlorine contact chamber.

Capacity: 25,000 GPD and the population served is 180.

Water Balance: Water is discharged to the Swift Creek Mine water system. Water uses discharge is summarized in Table 4.3-8.

Water Treatment: Extended aeration process followed by chlorination. The allowable effluent limitation in Florida is 90 percent treatment or better. There are no Florida construction permit applications.

The proposed well for the Chemical Plant is No. C-4 with a pumping capacity of 7,000 GPM and a depth of approximately 800 ft. The casing for the well is unknown at this time.

A deep well analysis of existing Swift Creek Mine well No. SC-1 is shown in Table 4.3-9. This is a 7,000 GPM well with 800 feet casing depth. It is expected that the well water analysis for the Swift Creek Chemical Complex will be similar.

The process chemicals for the Sulfuric Acid Plant Boiler and Cooling Tower will be given in Table 4.3-10.

The total defoamer use is budgeted at 700 metric tons per year and is used in Phosphoric Acid Plant D, 40 percent-54 percent Evaporation, Clarification, and the SPA plants for foam prevention. A water-soluble defoamer is used and ends up in the SPA acid, and the process water circuit. No discharge occurs to the nonprocess water system.

Total inorganic chemicals used are budgeted at 13,000 metric tons per year and leave the plant site as a by-product. No discharge occurs to the nonprocess water system.

Limestone use is budgeted at 6,268 metric tons per year and will leave the plant site as a by-product. Lime is budgeted at 643 metric tons per year and will be used to treat nonprocess water when it becomes contaminated.

60 percent of the electric power will be generated on-site using high pressure steam from Sulfuric Acid Plants E&F and the balance will be supplied by Florida Power Corporation.

4.4 POLLUTION CONTROL MEASURES

4.4.1 COOLING OF SPA

Two alternative pollution control measures are possible, such as the use of totally enclosed heat exchangers to cool evaporated SPA versus the use of cooling coils in vented tanks. The use of totally enclosed heat exchangers to preheat feed to the SPA units instead of cooling coils using pond water in vented tanks would reduce a small amount of fluoride emissions from the scrubber venting these tanks and would slightly reduce the amount of steam required for evaporation of SPA. Thereby decreasing the amount of boiler feed water chemicals discharged. Water evaporation from the process wastewater cooling pond would be slightly reduced, using totally enclosed heat exchangers; however, this pond is already designed for a negative water balance using these heat exchangers.

The main benefit with the totally enclosed heat exchangers is energy conservation. It is planned to design and install this system in the proposed SPA plants, althought it has not been proven on a commercial scale.

4.4.2 RETROFIT OF EXISTING SRCC SULFURIC ACID PLANTS

Retrofit of the existing sulfuric acid plants versus construction of new sulfuric acid plants to meet new source performance standards (NSPS) at the Suwannee River Chemical Complex has been considered.

Retrofit of the existing sulfuric acid plants would probably involve double absorption which would require an external heat source using sulfur containing fuel oil, because of the design of the existing plants. Resultant sulfur dioxide emissions to the air from the fuel oil plus the retrofitted plants (to NSPS) would exceed NSPS by a factor of 2 or more.

Replacement of the existing sulfuric acid plants with one large double absorption plant would require a capital expenditure of about $20 million.

Ambient air levels around the existing SRCC complex site meet EPA and Florida DER sulfur dioxide standards at the present time.

Considering the increase capital and fuel consumption for retrofitting the existing sulfuric acid plants, the large capital investment for a new double absorption sulfuric acid plant, and the fact that ambient air SO_2 standards are now being met, leads to a conclusion that both of these alternatives would be a waste of a valuable venture capital.

4.5 ALTERNATIVE OF NOT CONSTRUCTING A NEW SOURCE

4.5.1 THE ECONOMIC EFFECTS OF A NO-ACTION ALTERNATIVE

The effects of a no-action alternative on the local area can basically be seen in the baseline socioeconomic projections in Section 2.8. Those projections were made on the assumption that the expansion would not occur. Occidental has, of course, proceeded with Phase I of their expansion and will meet their commitments to the U.S.S.R insofar as possible. Thus, all or most of the international trade benefits of the agreement will be realized in any case. However, if the Phase II expansion were not completed most of Occidental's existing capacity would have to be devoted to satisfaction of the U.S.S.R. agreement. Thus, Occidental's capacity would be effectively removed from the available capacity to meet the U.S. phosphate fertilizer needs. As was shown in section 3.4.3, this capacity will be needed to meet the growing fertilizer requirements of U.S. farmers in the future.

Thus, a no-action alternative would result in a lower level of employment and incomes within the three-county area and Florida, higher unemployment, lower tax collections by local and state governments, and lower expenditures by local governments. State government expenditures would be little affected in either case. The no-action alternative would also, of course, result in a somewhat slower development of residential, commercial and industrial land than would be the case with the development.

With respect to the pace of residential, commercial and industrial land development, however, since it has been estimated that the effects of the expansion would be relatively minor, the effects of the no-action alternative would also be minor in this regard.

4.5.2 SUPPLY AND DEMAND FOR FERTILIZER

As has already been noted, if the new plant was not built it would be necessary for Occidental to meet its commitments to the U.S.S.R. from their existing plants. Thus, their capacity would not be available to supply phosphate fertilizer to meet U.S. demand. At the present, this would probably not result in any serious shortages of phosphate fertilizers within the country; however, if demand continues to grow as it has in the past, or as has been predicted for the future, either additional plant capacity would have to be built anyway or it would be necessary to import P_2O_5. This would, of course, negate much of the foreign trade benefits to be gained from the agreement with Russia.

Table 4.3-1 Water Summary (Based on 310 DPY Operating Time) -MGD- Swift Creek Chemical Complex-Overall Balance on Complete Complex

	MGD In	MGD Out
Well Water	3.68	
Rainfall	2.27	
Vent Air (including combustion water)	0.03	
Water in Raw Materials	0.14	
Natural Evaporation		1.03
Process Evaporation		0.63
Deposited Water with Gypsum		0.58
Chemically Combined Water		0.29
Chemically Combined Water in H_2SO_4		0.17
Scrubber Stacks		0.04
Cooling Tower Evaporation		1.68
Water in Products & By-Products		0.06
Nonprocess Water(1)		1.65
Sanitary & Regeneration Water to Mine Water		0.06
Deficit: Gypsum Stack & Cooling Pond	0.07	
TOTAL OVERALL BALANCE ON COMPLETE COMPLEX:	6.19	6.19

(1) To freshwater ditch; see individual process units for description--excludes rainfall run-off.

Table 4.3-2 Water Summary (Adjusted to 310 DPY Operation to Conform with Phosphate Units)--Swift Creek Chemical Complex-Sulfuric Acid Plants E & F

	GPM	
	In	Out
Fresh Water	869	
Nonprocess Water to Cooling Tower	1185(1)	
Condensate Return	379(2)	
Steam		403(3)
Demineralizer		13(4)
Cooling Tower Evaporation & Drift		1164
Nonprocess Water(5)		732
Water in H_2SO_4 - Free - to P_2O_5 Plant		12
Water in H_2SO_4 - Free - to Sales		6
Water in H_2SO_4 - Chemical		116
Vent Air	13	
TOTAL SULFURIC ACID PLANTS E & F	2446	2446

(1) From vacuum pump seals and miscellaneous cooling water
(2) Returned from phosphoric acid evaporators
(3) Net export steam
(4) To mine water circuit
(5) Cooling tower and boiler blowdown, cooling water, sulfur melting condensate; to freshwater ditch; excludes rainfall run-off

Table 4.3-3 Water Summary (Based on 310 DPY Operating Time)-
Swift Creek Chemical Complex-Phosphoric Acid Plant
D-Hemihydrate Process

	GPM	
	In	Out
REACTION & FILTRATION:		
Steam	73	
Cold Pond H_2O	10,769	
Phosphate Rock	86	
98% H_2SO_4 (Free Water)	12	
Fresh Water	910	
40% P_2O_5 Acid (Free Water)		201
Warm Water to Pond		10,648
Chemically Combined H_2O(1)		57
Nonprocess Water(2)		40
Seal & Cooling Water to H_2SO_4 Cooling Tower		820
Vent Air	6	
Condensate Return to H_2SO_4 Boilers		73
Stack		17
TOTAL REACTION & FILTRATION	11,856	11,856

(1) Gypsum cake hydration water

(2) Filter skirt sprays using well water (con-contact water) to freshwater ditch; excludes rainfall run-off

Table 4.3-4 Water Summary (Based on 310 DPY Operating Time)-Swift Creek Chemical Complex - 40% to 54% P_2O_5 Evaporation

	GPM	
	In	Out
Steam	190	
Cold Pond Water	8,489	
Feed Acid	207	
Vent Air	1	
54% P_2O_5 Acid		54
Warm Pond Water		8,643
Seal & Cooling Water to H_2SO_4 Cooling Tower		153
Condensate to H_2SO_4 Boilers		156
Stacks		3
Nonprocess Water		34
Fresh Water	153	
TOTAL 40%-54% P_2O_5 EVAPORATION	9,040	9,040

Note: Exludes rainfall run-off.

Table 4.3-5 Water Summary (Based on 310 DPY Operating Time)- Swift Creek Chemical Complex- Clarification

	GPM In	 Out
Steam	10	
Cold Pond H_2O	3,008	
Phosphoric Acid Feed	112	
Fresh Water	330	
Phosphoric Acid Product		117
Warm Pond Water to Pond		2,983
Nonprocess Water(1)		320
By-Products		32
Vent Air	4	
Stack		12
TOTAL PURIFICATION	3,464	3,464

(1) To Fresh Water Ditch; vacuum pumps seal water, air compressor cooling, and oil cooling; excludes rainfall run-off.

Table 4.3-6 Water Summary (Based on 310 DPY Operating Time)- Swift Creek Chemical Complex-Superphosphoric Acid Plants C & D

	GPM	
	In	Out
Steam	160	
Cold Pond Water	14,256	
54% P_2O_5 Acid	54	
70% P_2O_5 Acid		(30)(1)
Warm Pond Water		14,340
Seal Water to H_2SO_4 Cooling Tower		200
Condensate to H_2SO_4		127
Flashed Steam		33
Fresh Water	200	
TOTAL SUPERPHOSPHORIC ACID PLANTS A & B	14,670	14,670

(1) ( ) denotes negative; chemical water removed --Balance excludes nonprocess water and rainfall run-off.

Table 4.3-7 Water Summary (Based on 310 DPY Operating Time)-
Swift Creek Chemical Complex-SPA Storage & Shipping

	GPM In	 Out
Steam	3	
Fresh Water	5	
Product		3
Condensate to H_2SO_4 Plant		3
Pond Water	3	5
TOTAL SPA STORAGE & SHIPPING	11	11

Note: Balance exludes rainfall run-off.

Table 4.3-8 Water Summary (Based on 310 DPY Operating Time)-
Swift Creek Chemical Complex-General Facilities

	GPM In	GPM Out
Fresh Water	81	
Rainfall into Process Areas	3	
Sanitary Water to Mine Circuit		16
Rainfall to Ponds		3
Nonprocess Water(1)		65
TOTAL GENERAL FACILITIES	84	84

(1) To fresh water ditch; plant air compressor cooling, air conditioner cooling, oil cooling; excludes rainfall run-off.

Table 4.3-9 Swift Creek Mine-Fresh Well Water Analyses

CERTIFICATE OF ANALYSIS*

Laboratory Marks	Deep Well No. SC-1	
pH	6.4	
Color	15	
Odor	Indefinite	
Alkalinity	41	ppm
Total Hardness as $CaCO_3$	157	ppm
Total Solids	322	ppm
Total Volatile Solids	82	ppm
Fixed Solids	240	ppm
Nitrate Nitrogen (NO_3-N)	0.12	ppm
Sulfate (SO_4)	127	ppm
Hydrogen Sulfide	0.36	ppm
Chloride (Cl)	18	ppm
Fluoride (F)	1.6	ppm
Calcium (Ca)	62	ppm
Magnesium (Mg)	0.20	ppm
Iron (Fe)	0.60	ppm
Sodium (Na)	8.5	ppm
Potassium (K)	1.9	ppm
Non-Carbonated Hardness as $CaCO_3$	115	ppm
Silica (SiO_2)	34	ppm
Sodium Chloride (NaCl)	30	ppm

* Thornton Laboratories, Tampa, Florida, March 30, 1976

Table 4.3-10 Process Chemicals-Sulfuric Acid Plant Boiler and Cooling Tower Chemicals (at Rated Capacities)

Water Treatment Chemicals(1)

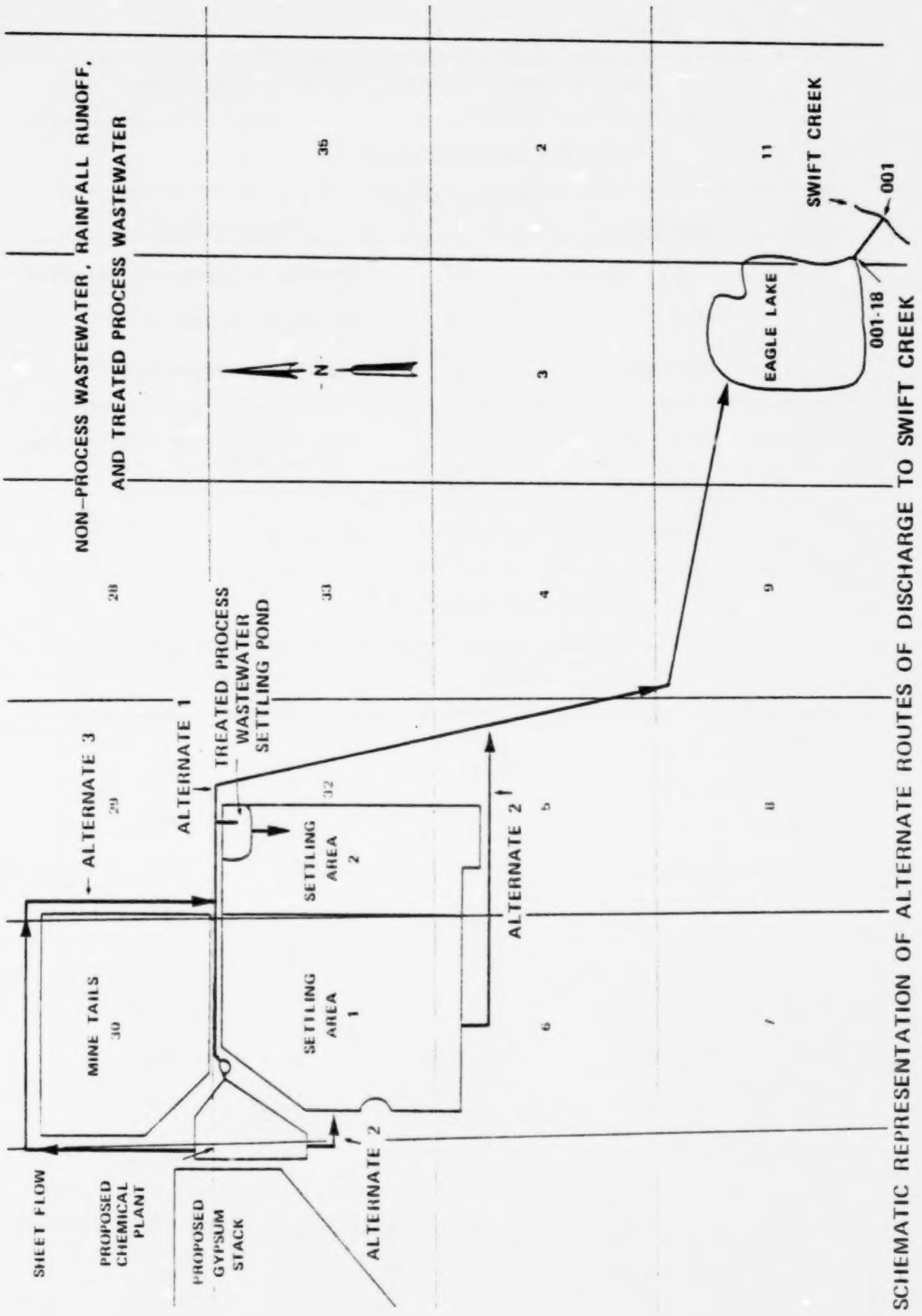
Unit	Material	Sulfuric Acid Plants E & F	Description
Boiler	Liqui-Treat	187	Organic & Inorganic Chetland
"	NA-5	12	Neutralizing Amine
"	Corrogen	36	Catalyzed Sodium Sulfite
Cooling	Betz 430 or 431	112	L.W. Polymer and Phosphonate Dispersant
"	Slimicide J-12	42	Non-Oxidizing Biocide
"	Chlorine	21	Chlorine

EFFLUENT LOADINGS(1)

Chemical	Sulfuric Acid Plants E & F lbs/day	Concentration Increase in Non-Process Water(2)	
Sulfate & Sulfide as SO_4	2,467	179	MG/L
Chloride as Cl	139	10.1	MG/L
Calcium as $CaCO_3$	1,646	120	MG/L
Magnesium as $CaCO_3$	623	453	MG/L
Silica as SiO_2	275	20	MG/L
Total Phosphate as PO_4	43	3.1	MG/L
Total Copper as Cu	0.15	10.9	μGM/L
Total Iron as Fe	3.7	0.28	MG/L
Soluble Zinc as Zn	0.25	18.2	μGM/L

(1) Betz Laboratories, Inc. to Occidental Chemical, 12/23/77 for SRCC, adjusted for SCC plants capacity

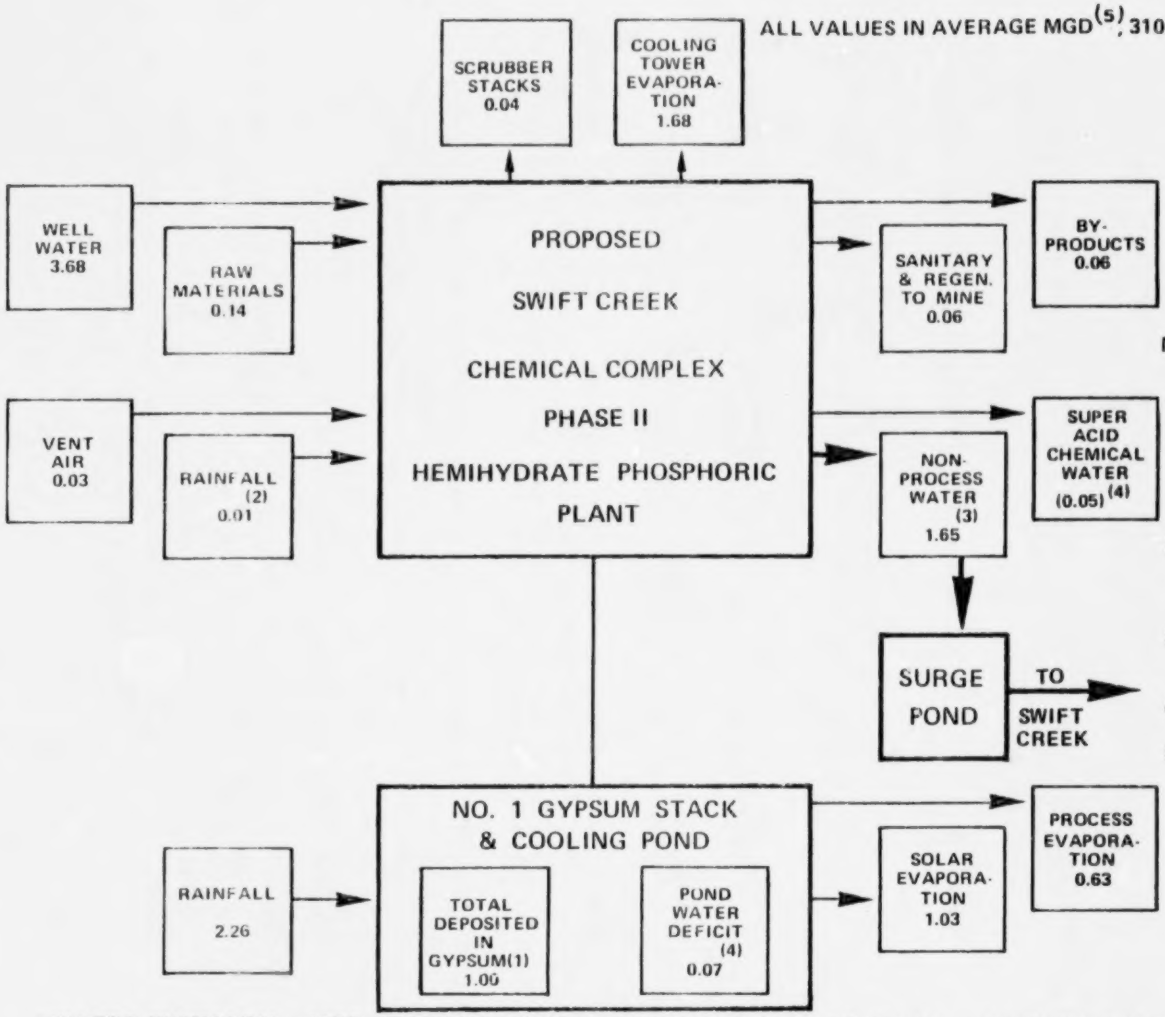
(2) Based on Fresh Water Ditch Flow of 1.65 MGD


SHEET FLOW
PROPOSED CHEMICAL PLANT
PROPOSED GYPSUM STACK
ALTERNATE 2
MINE TAILS
30
SETTLING AREA 1
SETTLING AREA 2
← ALTERNATE 3
29
ALTERNATE 1
TREATED PROCESS WASTEWATER SETTLING POND
32
ALTERNATE 2
28
33
NON-PROCESS WASTEWATER, RAINFALL RUNOFF, AND TREATED PROCESS WASTEWATER
N
35
6
5
4
3
2
7
8
9
11
EAGLE LAKE
001-18
001
SWIFT CREEK

SCHEMATIC REPRESENTATION OF ALTERNATE ROUTES OF DISCHARGE TO SWIFT CREEK

FIGURE 4.1-1

ALL VALUES IN AVERAGE MGD(5), 310 DPY OPERATING TIME


SCRUBBER STACKS 0.04
COOLING TOWER EVAPORATION 1.68
WELL WATER 3.68
RAW MATERIALS 0.14
VENT AIR 0.03
RAINFALL (2) 0.01
PROPOSED SWIFT CREEK CHEMICAL COMPLEX PHASE II HEMIHYDRATE PHOSPHORIC PLANT
SANITARY & REGEN. TO MINE 0.06
BY-PRODUCTS 0.06
NON-PROCESS WATER (3) 1.65
SUPER ACID CHEMICAL WATER (0.05)(4)
SURGE POND
TO SWIFT CREEK
RAINFALL 2.26
NO. 1 GYPSUM STACK & COOLING POND
TOTAL DEPOSITED IN GYPSUM(1) 1.00
POND WATER DEFICIT (4) 0.07
SOLAR EVAPORATION 1.03
PROCESS EVAPORATION 0.63

NOTES:

1. INCLUDES CHEMICALLY COMBINED AND FREE WATER IN GYPSUM PLUS CHEMICALLY COMBINED WATER IN SULFURIC ACID.
2. LIMITED TO RAINFALL INTO PROCESS AREAS DRAINING TO COOLING PONDS.
3. DISCHARGED TO NON-PROCESS WATER SURGE POND.
4. ( ) DENOTES NEGATIVE VALUE.
5. MILLIONS OF GALLONS PER DAY.

WATER SUMMARY – MGD PROPOSED SWIFT CREEK CHEMICAL COMPLEX – HEMIHYDRATE PHOSPHORIC PLANT

FIGURE 4.3-1

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Suwannee River Chemical Complex, Aerial Photographs of Suwannee River Chemical Complex Plant Site--Scale, 1" = 333'.

Suwannee River Chemical Complex, Aerial Photograph of Suwannee River Chemical Complex Area including Ponds and NPDES Discharge Point 001--scale, 1" = 1000'. Nonprocess water, process water, and rainfall routes outlined by Occidental Chemical Company Environmental Personnel.

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SECTION 5.0

MITIGATIVE MEASURES

5.1 AIR QUALITY AND NOISE

5.1.1 AMBIENT AIR QUALITY

The U.S. Environmental Protection Agency and the Department of Environmental Regulation of the State of Florida have established the following standards that define acceptable ambient concentrations of air contaminants consistent with established air quality criteria. The following standards are taken from Chapter 17-2 of the Department of Environmental Regulation.

5.1.1.1 Particulate Matter

1. 60 micrograms per cubit meter - annual geometric mean.
2. 150 micrograms per cubic meter - maximum 24-hour concentrations not to be exceeded more than once per year.

5.1.1.2 Sulfur Oxides (Sulfur Dioxide)

1. 60 micrograms per cubic meter (0.02 ppm) - annual arithmetic mean.
2. 260 micrograms per cubic meter (0.01 ppm) - maximum 24-hour concentration not to be exceeded more than once per year.
3. 1,300 micrograms per cubic meter (0.50 ppm) - maximum 3-hour concentration not to be exceeded more than once per year.

5.1.1.3 Photochemical Oxidants

1. 160 micrograms per cubic meter (0.08 ppm) - maximum 1-hour concentration not to be exceeded more than once per year.

5.1.1.4 Hydrocarbons (As Measured and Corrected for Methane)

1. 160 micrograms per cubic meter (0.24 ppm) - maximum 3-hour concentration (between 6 a.m. and 9 a.m.) not to be exceeded more than once per year.

The hydrocarbon air-quality standard is for use as a guide in determining hydrocarbon emission control required to achieve the photochemical oxidant standards.

5.1.1.5 Nitrogen Dioxide

1. 100 micrograms per cubic meter (0.05 ppm) - annual arithmetic mean.

5.1.1.6 Carbon Monoxide

1. 10 milligrams per cubic meter (9 ppm) - maximum 8-hour concentration not to be exceeded more than once per year.
2. 40 milligrams per cubic meter (35 ppm) - maximum 1-hour concentration not to be exceeded more than once per year.

In addition to the above pollutants regulated by state and federal agencies, the Department of Environmental Regulation of the State of Florida (FDER) also has established the following guideline.

5.1.2 EMISSION REGULATIONS

Industrial emissions are regulated by a series of stipulations all contained in Chapter 17-2.04 of the Florida Administrative Code (F.A.C.) These regulations include general provisions dealing with limits on visible emissions, process weight table, etc., but in addition has specific industry limitations, some being applicable to the phosphate fertilizer industry. By reference, when federal New Source Performance Standards exist for a particular industry or process (such as sulfuric acid plants) then these standards apply rather than the limits of 17-2.04. Emission limits of particular interest in this EIS and taken from 17-2.04 are as follows:

5.1.2.1 Sulfuric Acid Plants

5.1.2.1.1 Existing Plants --

a. Ten pounds SO_2 per ton 100% H_2SO_4 or 29 pounds SO_2 per ton in the Jacksonville-Brunswick Interstate Air Quality Control Region (an area that includes Occidental Chemical Company).

b. Visible emission limit of 5 percent opacity except for startup periods.

5.1.2.1.2 New Plants --

a. Four pounds SO_2 per ton 100 percent H_2SO_4

b. Acid mist up to 0.15 pound per tons of 100 percent H_2SO_4

c. No visible emissions except during startup

5.1.2.2 Phosphate Processing - Limits Expressed as Pound of Fluoride (Atomic Weight 19) Per Ton of P_2O_5 Equivalent of Input Material

5.1.2.2.1 New Plants --

a. Wet process phosphoric acid production - 0.02 pounds F per ton P_2O_5 fed.

b. Superphosphoric acid production - 0.01 pounds F per ton P_2O_5 fed.

c. All other plants or processes will be subject to best technology.

5.1.3 PREVENTION OF SIGNIFICANT DETERIORATION

Final regulations by EPA were issued in June 1978 and Florida dopted regulations compatible with those of EPA. The new "PSD" regulations as reflected in Chapter 17-2.02 established three area classes and established degradation limits in each. Class I, II and II areas are designated in descending order of air quality, i.e., a Class I area is to be as free of air pollution as possible and at present is assigned to federally designated seashore and national forest areas. One such area near the Occidental Chemical site is the Okefenokee National Wilderness area. All other areas are Class II. Table 5.1-1 gives allowable incremental impacts under this FDER regulation.

At the present time, no Class III areas have been designated in Florida.

Table 5.1-1 Allowable Incremental Impacts under PSD Regulations

Pollutant/Time Period	FDER AQS ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$) Class I	Class II	Class III
Particulate Matter*				
Annual	60	5	19	37
24-hour	150	10	37	75
Sulfur Dioxide				
Annual	60	2	20	40
24-hour	260	5	91	182
3-hour	1300	25	512	700

* Does not include background

5.2 LAND AND WATER RESOURCES

5.2.1 TOPOGRAPHY

The proposed site is located outside the limits of stream courses and flood-prone-areas in the Swift Creek drainage basin.

Retirement of the gypsum stack could consist of flattening its slopes and incorporating a clayey soil cover that will be grassed, as described in Section 5.2.3.3.

5.2.2 GEOLOGY

The chemical plant will not have any effect on the main Hawthorn confining unit. There are no mitigating measures for the loss of mineral resources that are mined. These resources will be mined irrespective of the proposed chemical plant.

5.2.3 SOILS

5.2.3.1 Erosion Control

Section 3.2.3.1 discussed in detail mitigative measures that will be taken to control erosion and protect the environment during construction. Building, embankment, storage and borrow areas will be grubbed only as necessary just prior to construction. Borrow areas that will not be used for mining purposes will be revegetated to reduce the incidence of erosion. Runoff from the earthen embankments and from the plant site will be collected in ditches and clarified before it is permitted to enter surface water courses, with further clarification occurring at Eagle Lake prior to discharge to Swift Creek. Runoff from exposed mining areas and spoil piles will be collected in perimeter ditches and in adjacent mine pits and will be clarified before being allowed to enter surface water courses to meet state water quality regulations.

5.2.3.2 Dust Control

During construction, heavy traffic areas will be wetted down to control dusting. Roads within the chemical complex will later be paved to prevent dusting. Other areas disturbed during construction will be grassed.

5.2.3.3 Gypsum Stack Retirement

Mitigative measures to reduce and/or eliminate potential impacts from the retired gypsum stack could include: (i) digging out some of the gypsum and selling it as a soil conditioner for farming (e.g., peanuts); and (ii) flattening the slopes of the gypsum stack and covering the gypsum surface with a 2- to 3-foot thick "impervious" clay liner, as is customarily done for a sanitary landfill. This should prevent further percolation and leaching of the gypsum and would reduce or eliminate the contamination of surface runoff requiring treatment. The clay cover could be seeded with grass having a shallow root system, such as that used for pasture. This would significantly reduce or even eliminate the potential for dust and erosion.

5.2.4 SURFACE WATER QUANTITY

Mitigative measures to reduce non-process water discharges to Swift Creek include: (i) the recycling of equipment cooling water and vacuum pump seal water from the phosphoric acid processes (Phosphoric Acid Plant "D," Evaporation Plant, Superphosphoric Acid Plants "C" and "D") to the sulfuric acid plants cooling tower for use as make-up water; and

(ii) the recycling of evaporator condensate from the phosphoric acid processes to the sulfuric acid plant boilers.

Measures to limit the discharge of treated process water to periods of heavy rainfall include: (i) the production of 98% sulfuric acid instead of 93% acid which increases the heat of reaction in the wet process phosphoric acid plant reactor, thereby increasing the process water pond deficit; (ii) the design of a process water pond system with a negative water balance; and (iii) incorporating in the design of the gypsum stack-cooling pond system a surge capacity for "zero" discharge; i.e., rainfall from the 25-year/24-hour storm can be stored within the system. The cooling pond will be designed to maintain 1.5 times the volume of precipitation from the 25-year/24-hour storm. Thus, while still maintaining the necessary freeboard, rainfall from the 25-year/ 24-hour storm will not completely use up the available surge.

The negative water balance designed into the system will make it possible to direct some of the non-process water to the process water pond during dry periods, thus reducing the discharge of non-process water during these periods.

Other mitigating measures include monitoring of Occidental discharges and Swift Creek flows (by the stream gauge recorders installed in conjunction with this study) and reporting the data to EPA and the Florida DER.

5.2.5 GROUNDWATER QUANTITY

5.2.5.1 Surficial Aquifer

A below-ground cooling pond will surround the gypsum stack. The water level in the cooling pond will be maintained within a few feet of the water-table in the surficial aquifer. These measures will eliminate potential effects on the groundwater level in the surficial aquifer and the impacts, if any, would be very localized.

5.2.5.2 Floridan Aquifer

Mitigative measures will be taken to limit the withdrawals from the Florida Aquifer. These measures include: (i) the production of 98 percent sulfuric acid instead of 93 percent acid which eliminates the need for 98-93 percent dilution coolers: this measure decreases the free water in the product (sulfuric acid) and reduces the heat load to and the evaporation from the cooling tower, thereby reducing well water use; (ii) the recycling of 1365 gpm of equipment cooling water and vacuum pump seal water from the phosphoric acid processes to the sulfuric acid plant cooling tower for use as make-up water; and (iii) the recycling of about 637 gpm of evaporator condensate from the phosphoric acid processes to the sulfuric acid plant boilers. These measures significantly reduce the well water consumption.

Monitoring of water levels in observation wells installed in conjunction with this study and in existing Occidental supply wells will be undertaken as a mitigating measure for assessing the impact of withdrawals and leakage on groundwater quantity.

5.2.6 SURFACE WATER QUALITY

5.2.6.1 Construction Phase

Mitigative measures to prevent the contamination of surface waters by suspended solids during the construction phase of the project have been summarized in Section 5.2.3.1. These measures consist of clarifying the runoff in surface water bodies prior to discharge to Swift Creek. Potential erosion from dikes will be mitigated by maintaining perimeter ditches, thereby creating a closed system that will discharge to surface waters after clarification occurs in various ponds and lakes.

5.2.6.2 Treated Process Water Discharge

As outlined in Section 5.2.4, mitigative measures will be taken to limit the discharge of process water to periods of excessive rainfall. If discharged, process water will be treated in a two-stage neutralization system using limestone and lime. The process water will be allowed to settle in a settler or settling pond after each treatment stage to remove suspended solids. Provision for enough surge to collect the 25-year/24-hour storm in the cooling pond prevents overloading the neutralization system and allows good control of the neutralized water to meet discharge standards. Treatment of process water will be limited to periods of heavy rainfall; i.e., whenever more than 50% of the available surge is used.

Routine monitoring of the level of water in the process water pond allows for the maintenance of the surge for the 25-year/24-hour storm. Monitoring and control of the water level in the below-ground cooling pond and/or the interceptor relief ditches surrounding the gypsum stack and any above-ground cooling pond allow for collection of the seepage.

Monitoring will be done by sampling and by performing chemical analyses on treated process water effluent when discharging, in order to be in compliance with NPDES permit conditions.

5.2.6.3 Non-Process Water Discharge

Non-Process water will discharge to a fresh water ditch in the chemical plant leading to a non-process surge pond. Effluent from the surge pond follows another fresh water ditch discharging into Eagle Lake (in Section 10) which, in turn, discharges into Swift Creek.

Mitigative measures that will be taken by Occidental Chemical Company to reduce the potential of non-process water contamination include: (i) the use of wet phosphate rock instead of dry rock, a measure which eliminates the need for a dryer and dryer scrubber, thus eliminating the potential pollution from weak sulfurous scrubber liquor containing suspended solids; (ii) recycling of phosphoric acid evaporator condensate to the sulfuric acid plant boilers, thus reducing the amount of water treatment regeneration effluent; and (iii) the diversion of contaminated phosphoric acid evaporator condensate to the process water circuit in order to reduce the amount of contaminated non-process water requiring treatment.

Prevention and control of contamination of non-process water will be accomplished by: (i) the isolation of non-process water from the process water and acid storage areas - the contaminated areas will be curbed and separated from non-process waters and rainfall runoff ditches; (ii) any point source non-process water discharge that could become contaminated by leaks or spills from acid areas will be routinely pH monitored to allow for diversion of the contaminated water to the process water system for as long as the pH is not back to normal; (iii) non-process water that is not contaminated and rain runoff from non-process areas will be diverted to the non-process surge pond which will have a retention time of about 100 days except during rainfall periods. The influent to and effluent from the surge pond will have an automatic continuous pH recording and alarm system to prevent discharges of contaminated water to surface streams and to allow for prompt corrective action to be taken. The 100-day retention time will also dampen any contamination of non-process water entering the pond; (iv) if contamination occurs, the discharge will be diverted to the second stage process water treatment system for neutralization with lime and settling in a pond so that the contaminated non-process water meets discharge requirements; and (v) any treated overflow from the settling pond and uncontaminated effluent from the surge pond will be discharged to Eagle Lake for final clarification. This lake has a retention time of 156 days except during rainfall periods. The extended retention time will allow for removal of suspended solids and will further dampen out pH and contaminants should all of the above control actions malfunction, a hypothesis that is highly unlikely.

Some non-process water discharges will be diverted to the Swift Creek Mine water circuits. These include: (i) the discharge of water treatment regeneration effluent (≈13 gpm) diverted to the mine water circuits in order to reduce the concentration of regeneration chemicals discharged to surface waters; and (ii) the discharge of treated domestic wastewater (≈16 gpm) after treatment to Florida DER Standards, diverted to the mine water system to eliminate the discharge of treated domestic water to surface waters.

Occidental Chemical Company will also reduce or possibly eliminate its discharges during drought periods which will, in turn, reduce and/or eliminate the potential impacts of discharges on surface waters during low flow conditions. The non-process surge pond with 100-day detention time, and Eagle Lake with 156-day detention time, allow for the control and management of discharge in dry periods to minimize the effect of changes in surface water quality of Swift Creek and the Suwannee River. The temporary storage of effluents in retention ponds and lakes will allow for future discharge to Swift Creek when flow conditions in the Suwannee River are more suitable.

Monitoring in order to comply with NPDES permit conditions will be done by sampling and performing chemical analyses on non-process water effluent, and by recording the discharge rate and reporting the data to EPA and the Florida DER. Further, the stream gauge recorders installed in conjunction with this study will be maintained and the records will be analyzed as data is accumulated. Surface water sampling and water analyses at the location of the stream gauges will continue on a regular bi-monthly basis during construction and operation of the proposed facility.

5.2.6.4 Retirement Phase

After retirement, continued treatment of runoff from the gypsum stack-cooling pond complex would continue to be required until the runoff is of acceptable quality that satisfies discharge standards.

5.2.7 GROUNDWATER QUALITY

Mitigative measures have been incorporated in the two design schemes that are being considered for the gypsum stack-cooling pond complex. In mined-out areas, a below-ground cooling pond will surround the stack and will act as a relief for water seeping from the stack area. Where an above-ground cooling pond surrounds the stack, its outer periphery will be excavated to provide a relief for water seeping from the stack. Seepage from the stack and above-ground cooling pond would, therefore, tend to flow to the below-ground cooling pond which acts as a sump.

The impacts of the proposed facilities will be directly measured by monitoring water quality in the observation wells installed in conjunction with this study. This sampling will be done at least twice a year on a regular basis during construction and operation of the proposed facility.

Occidental Chemical Company proposes to operate with the level of water in its below-ground cooling ponds slightly above the water-table in the surficial aquifer. In the unlikely event that the monitoring program indicates significant contamination of the surficial aquifer, Occidental will lower the operating level of its below-ground cooling ponds to provide additional relief for water seepage. This measure would, however, reduce the process water pond deficit, thereby requiring more treatment and discharge of process water to surface streams.

Occidental will not extend its mining at the site of the gypsum stack-cooling pond complex into the confining unit and, hence, the confining bed of the Floridan Aquifer would not be affected by mining operations. No measurable impacts are projected on water quality in the Floridan Aquifer. The water quality in the aquifer will, however, be monitored through Occidental supply wells and the deep observation wells installed in conjunction with this study.

5.2.8 ACCIDENTS AND SPILLS

The gypsum stack-cooling pond complex will be designed in accordance with State-of-the-Art practices. Although the site is not susceptible to damaging earthquakes, the design will also comply with requirements of Earthquake Zone 1 (Section 2.4.5). There are no state or federal rules that apply to the design of the gypsum stack.

The rules of the Department of Environmental Regulation for the design, construction, inspection and maintenance of earthen dams promulgated under Chapter 17-9, Florida Administrative Code, will be strictly adhered to. Earthen retaining dikes will also comply with all other state and/or local ordinances.

The construction of retaining dikes will be inspected daily by a qualified representative of the design engineer to determine that the embankments, spillways and control structures meet the design specifications. Prior to the introduction of process water into the area, the entire earthen structure will be thoroughly inspected by the design engineer.

The earthen dikes, cooling pond-gypsum stack complex will be inspected on a routine basis by operations personnel, who will be instructed by the design engineer regarding items to be checked. The inspection will consist of checking the general condition of the crest and toe inspection roads, the condition of soil surfaces on the outside slopes and downstream from the toe, the elevation of the impounded fluid, the piezometric level within and adjacent to the embankments, and non-process water ditches and surge ponds. Evidence of concentrated seepage, cracking or subsidence of the crest, sloughing of the downstream toe, or the appearance of significant erosion gullies will be immediately brought to the attention of the design engineer. Remedial measures will be taken as soon as an unexpected condition is detected in order to prevent leaks and/or dike failure.

A thorough and detailed annual inspection will also be undertaken by a qualified geotechnical engineer until the gypsum stack is ultimately retired.

The probability of having a spill of the ponded water on top of the stack is very low. Nevertheless, the cooling pond surrounding the stack is designed with enough surge capacity to contain acid water that may be stored on top of the stack. Such a spill will cause a rise in the water level of the cooling pond that will not exceed one foot (and more than likely, will be on the order of 0.5 feet). This is well within the available surge capacity.

The isolation of acid process areas and acid storage areas from non-process water and rainfall runoff ditches reduces the potential of contamination of non-process waters. Mitigative measures outlined in Section 5.2.6.3 allow for the recovery of process water from leaks and spills (by diversion to the process water system) and/or for treatment of the contaminated waters prior to discharge.

5.3 BIOLOGY AND ECOLOGY

5.3.1 AQUATIC COMPONENTS

Construction runoff will be impounded to allow suspended sediments to settle prior to discharge. These retention ponds will mitigate the potential impact to aquatic organisms.

Discharges of the plant will be nonprocess and treated process water. These waters will be routed through the Eagle Lake Retention System, allowing clarification and partial treatment of dissolved and suspended materials.

5.3.2 TERRESTRIAL COMPONENTS

Incorporation of storm runoff retention ponds during construction phases of the proposed chemical plant will minimize any potential sedimentation damage to the vegetation of Swift Creek Swamp. Since the impacts to birds and mammals is related more to increased disturbance and habitat loss during construction, there are few mitigating measures that would affect wildlife. Providing natural plant species in abundance on areas that are cleared, but not utilized for buildings, roads, etc., would provide food and cover for wildlife to some degree.

Meeting state and federal air emission standards will mitigate the impact of chronic injury to vegetation from sulfur dioxide, acid mist and fluorides. Uncontrolled sources of materials such as volatilization of fluorides from cooling ponds are difficult to limit and, therefore, lessening their impact would be difficult to achieve. Such is the case with periodic releases of sulfur dioxide and acid mist during plant upsets.

Storing nonprocess waters in reservoirs and releasing these waters to Swift Creek during low flow regimes would minimize the potential for flooding damage to vegetation in flood-prone areas of Swift Creek.

5.4 MITIGATIVE MEASURES TO ALLEVIATE ADVERSE EFFECTS ON THE SOCIOECONOMIC ENVIRONMENT

5.4.1 INTRODUCTION

It should first be noted that most of the socioeconomic effects of the proposed expansion are beneficial rather than harmful. That is, the main socioeconomic effects of the expansion will be to: 1) increase the total and per capita incomes of the people in the immediate impact area, the State of Florida and South Georgia; 2) increase the level of employment and reduce the rate of unemployment within the immediate area, the State of Florida and South Georgia; and 3) improve the U.S. balance of trade, contribute toward a more favorable national resource balance, and contribute toward a more efficient utilization of the nation's energy resources (especially natural gas). The first two of these main effects are especially important to the local area and to the State of Florida, which has been experiencing a very high rate of unemployment over the past few years. The third is important to the whole country, not just to Florida.

Nevertheless, the benefits to be gained by the people of the area as a result of the project will not be gained without socioeconomic costs. The main costs which _may_ be incurred can be categorized as follows:

1) Either deterioration of the quality education or an increase in educational costs;

2) Either a deterioration in the adequacy of utility, sewerage, police, and other public services or an increase in their costs;

3) Either a deterioration of the quality of transportation (perhaps in the form of greater conjestion) or an increase in transportation costs;

4) A reduction in income and employment resulting from a diversion of land from agriculture, forestry, or other productive uses to residential, street, or other such uses;

5) A reduction in the quality of public recreation facilities as a result of their overuse or overcrowding or an increase in the cost of recreation;

6) A loss of a psychic feeling of well-being as a result of more crowded living conditions, a loss of open space, etc.; or

7) Speeding up of the rate of depletion of one of the countries (and Florida's) natural resources, which are, from a strict point of view, limited in quantity.

5.4.2 MITIGATIVE MEASURES OR CONDITIONS

In this section suggestions are made of measures which might be taken or offsetting circumstances which may act to mitigate the adverse effects listed above.

5.4.2.1 Education

As was shown in Section 3.4.2., it is not likely that the costs of education to the State of Florida will increase at all as a result of the expansion.

However, school enrollment is expected to increase modestly within the local impact area as a result of the expansion. It is estimated that some 66 more students will be there by 1979 than would be there otherwise. It is also projected that some 689 more will be there in 1980 than would have been there otherwise. As of 1980 this represents less than a 5 percent increase as a result of the expansion. It is, of course, not known at this stage where those 689 new students will be in school; i.e., which of the school systems will have to provide for them.

For those who will be in school in Hamilton County, a mitigating influence will be that Occidental alone will pay much more than enough in additional property taxes to cover the added cost of the additional students. For those who live in the other counties of the area, the school systems will have to rely largely on increases in property taxes paid by their parents, increases in per student transfers from the state government, or possibly increased property tax rates if revenue increases are not sufficient otherwise. There is, of course, generally a lag between the time of increased enrollments and the time that increased revenues are realized. Thus, there may be an initial period in which schools are overcrowded or during which increased costs are greater than increased revenues. The degree to which this is a problem is likely to depend upon the locational patterns of the new population. This can be controlled to some degree through effective planning and zoning.

5.4.2.2 Utilities, Sewerage, Police, and Other Local Public Services

The population and household growth which is projected to result from Occidental's proposed expansion will, no doubt, place some strains on the ability of the local governments to maintain both the quality and the quantity of services that they must provide. On the other hand, especially in Hamilton County, there certainly should be sufficient additional tax revenues to cover any increased costs that may result. The other two counties most affected by the expansion (Columbia and Suwannee) may find it more difficult to cover the increased costs. Of course, the increased population, additional housing and commercial construction, and other land improvements in each county which result from Occidental's expansion will result ultimately in an increased property tax base. In addition, the increased population will also ultimately result in increased transfers from state and federal governments. Whether or not these increases in revenues will be sufficient to cover the increased costs without tax rate increases cannot be said at this point. Again, however, there will certainly be a lag between the time that increased costs occur and the time that increased revenues are received. If this lag is anticipated and planned for its fiscal effects on the local governments can be mitigated.

Also, by effective planning throughout the three-county area the possible adverse effects on the adequacy of public services of the influx of new people into the area can be mitigated. As has been pointed out in Section 2.8.1, the Florida Local Government Comprehensive Planning Act of 1975 provides that all local governments must complete and adopt comprehensive plans by July 1, 1979. The North Central Florida Regional Planning Council is now working with all of the local governments in the area to this end. The staff of the North Central Planning Council has been contacted several times during the conduct of the present study and have been apprised of the general order of magnitude of the impacts that might be expected. It is expected that they will have full knowledge of the likely impacts before the plans for the local governments of the area are completed and thus can take the projected growth into account.

5.4.2.3 Transportation

Clearly, a substantial influx of new people and new business activity into an area can overtax the transportation facilities which the area has, causing highway and street traffic conjestion, increasing accident rates, and so forth. As was shown in Section 2.8.1; however, the area of immediate impact is well served by major traffic arteries and it is likely that these will be sufficient to handle the required traffic flow for some time into the future. The roads leading to Occidental's existing Suwannee River site (State Highway 137) as well as the Swift Creek site (U.S. Highway 41) are in excellent condition. The former has recently been upgraded to federal highway standards. It is envisioned here that the only additional street or highway construction that might be needed as a result of Occidental's expansion will be residential streets in new subdivisions that might be built in or near the existing urban centers.

There is presently a public transit system operating in the area which transports some Occidental employees (and others) to and from work. An expansion of the services of this system will contribute significantly toward mitigating any transportation problems that may result from the expansion program.

5.4.2.4 Reduction of Income and Employment in Agriculture, Forestry, Etc.

If the influx of new people into the area as a result of Occidental's expansion had the effect of diverting land now used in farming, forestry, or other such uses to residential uses this could have the effect of reducing employment and incomes generated by those activities. It is not envisioned, however, that very many acres of land will be diverted to residential or commercial uses as a result of Occidental's expansion. In Section 3.4.2, for example, it was estimated that by 2000 some 368 acres in the three counties of immediate impact would be diverted to residential use as a result of Occidental. These acres are likely to be inside or near the existing urban concentrations and are not likely to affect the acreage available for forest or agricultural uses. There will probably also be a few acres diverted to commercial uses but these too will be in or near existing urban concentrations.

As has been pointed out in Section 2.8.1, under the Local Government Comprehensive Planning Act of 1975, all local governments are now required to have comprehensive land use plans and to adopt zoning ordinances to assure conformity of land uses to the plans as officially adopted. Thus, the governments in the impact area have it in their power to assure that any new developments are in conformity with the plans. It should be noted further that the land to be mined is already owned by or under lease to Occidental Chemical Company. It is already classified as extractive use land, is not being used for any other purposes, and will be mined in any event. It should also be noted that Occidental's mining activities over the past decade or so has not materially affected agriculture in the area.

5.4.2.5 Reduction of the Quality of Public Recreation

It is true that additional people in the area will place an added burden on the quality of recreation that can be provided by existing facilities. Whether or not there will be a serious reduction in the quality of service will depend on the extent of present use relative to capacity, the extent to which new arrivals into the area use the facilities, and the extent to which local officials anticipate potential recreational problems and act to prevent any deterioration in the quality and quantity of recreation available.

Here again, this is primarily a function of advanced planning and federal money is generally available for recreational facilities.

5.4.2.6 Loss of Citizen Well-Being Due to Crowding and Loss of Open Space

Undoubtedly there would be a psychic loss to the people in the impact area if the population and commercial growth of the area as a result of Occidental's expansion were to be such that large numbers of new people were to come in, and residential and commercial density were to, as a result, increase very substantially. In the first place, however, it is only estimated that there will be some 4.3 percent more people there over the period from 1980 to 2000 than there would be otherwise. This does not constitute a massive influx of new people. Thus the increased residential and commercial density in the area will hardly be noticeable. In the second place, the local governments have it in their power to affect the location of new residential and commercial developments in such a way as to minimize any appearance of either urban sprawl or excessive crowding.

5.4.2.7 Accelerated Depletion of a Natural Resource (Phosphate)

It is true that construction and operation of the proposed new plant will very likely accelerate the depletion of the phosphate reserves in Hamilton County. There is technically a finite amount of phosphate rock available in Florida and elsewhere in the United States and any which is mined now will not be available for future generations.

On the other hand, the loss of this resource will be mitigated, as spelled out in detail in Section 3.4.3, by the import of ammonia, urea, and potash into the United States. Phosphate is a resource which the United States has in relative abundance whereas we have very limited potash reserves and our known reserves of natural gas, the primary ingredient of both ammonia and urea, are rapidly running out. Thus, while it is true that construction of the plant will speed, by a small degree, the depletion of our phosphate rock reserves, it is also true that this will reduce the rate of usage of natural gas which is in much shorter supply than phosphate. For the people of Florida, of course, the depletion of the nation's natural gas reserves may be of less concern than the depletion of their own phosphate reserves; a resource on which many of their people depend. Thus, while the time bought for the nation to find alternative energy sources will mitigate to some degree the effects of a reduction in the nation's phosphate reserves.

5.5 RADIOLOGICAL

5.5.1 SURFACE WATERS

Off-site impact of radioactivity in surface waters will be mitigated by compliance with a NPDES permit limiting effluents to less than 9 pCi/l radium-226. The surface water surveillance data indicate that off-site surface waters will remain near the radioactivity levels of natural surface waters in the area (less than permit condition).

5.5.2 GROUNDWATERS

Groundwater contamination by other pollutants of a more soluble nature is likely to be the critical factor in identifying seepage. Radium-226 is extremely insoluble and seepage water traveling downward through the strata must pass through areas containing high quantities of radium-226. If mitigative measures for other contaminants are instigated, it appears that this will be sufficient to insure that groundwater contamination by radium-226 is not a problem.

5.5.3 GYPSUM STACK

The EPA area-wide EIS (EPA, 1978) listed under "Proposed Actions" that lining of gypsum ponds with an impervious material as a mitigative measure to protect groundwwater from radiological contamination unless site specific data indicate otherwise. The north Florida site results in gypsum having a concentration of radium-226 approximately one half that of west central Florida. Proposed designs for the gypsum stack mitigates gradients for seepage of any dissolved radium-226. Lateral transport of fine suspended particulates is not expected. The mitigative measure proposed for retiring the gypsum stack (Section 5.2.3.3) is considered adequate for long-term control of the radiological aspect of this approximately 14 pCi/g radium-226 material.

LIST OF REFERENCES
(SECTION 5.5)

EPA (1978), "Draft Areawide Environmental Impact Statement; Central Florida Phospahte Industry", U.S. Environmental Protection Agency, 904/9-78-006.

5.6 CULTURAL RESOURCES

Historical and archaeological survey has failed to reveal sites of National Register significance on the Occidental SPA tract. A nearby settlement of mill shanties associated with the Camp lumber operation was found to date to the turn of the century. Camp's Still is neither within the survey area nor considered eligible for inclusion in the National Register. No evidence of prehistoric occupation could be found despite examination of large areas of cleared ground. Generally, the tract has been severely disturbed by mining, clearcutting, pine cultivation, industrial development, and utilities and transportation construction. No mitigation is required. (See letter of L. Ross Morrell, Deputy State Historic Preservation Officer dated January 26, 1978 concurring in a determination of no effect).